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TENANCY, LAND-USE, AND FARM MANAGEMENT PRACTICES IN MACALONG, ASINGAN, PANGASINAN [1]

SANTOS G. ARAGONES

WITH ONE TEXT FIGURE

Of the 117 farmers interviewed, 24 were owners, 25 were part-owners, and 68 were tenants. The average size of cropland was 1.20 hectares, of which 1.13 hectares were double cropped with palay and mungo.

Most of the landlords were entirely dependent on the income derived from the farm while a number of them were farmers themselves.

There was a direct relationship between net farm income and operator's years of schooling, crop yield index, and size of cropland.

Since the Philippines is primarily an agricultural country problems affecting tenancy, use of land, and farm management practices need first consideration.

Arnaldo and Velmonte [2] studied the tenant-operated rice farms of the College and found that the average labor income of a tenant was only ₱41.09 for lowland rice. This low income was due to the small area operated. Sacay and Naanep [3] reported that in the barrios of Cabuyao, Laguna, the small size of farms, poor farming methods, one-crop system of farming, and low educational attainment are responsible for the small income of rice farmers.

To obtain further information that may suggest possible solutions to these problems this survey was conducted in the summer of 1955, in the barrio of Macalong, Asingan, Pangasinan. Data on tenancy, land-use, and farm management practices for the crop year 1954-55 were secured from personal interviews with 117 farmers chosen to represent the barrio.

THE MACALONG AREA

Macalong is a barrio of Asingan, a second-class municipality in eastern Pangasinan. It is traversed by a macadamized road that

[1] Central Experiment Station Contribution No. 1903. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1956. Prepared in the Department of Agricultural Economics under the direction of Visiting Professor Horst Von Oppenfeld.

[2] M. V. Arnaldo and J. E. Velmonte, Philippine Agriculturist, **30**, 465 (1941).

[3] F. M. Sacay and R. F. Naanep, Philippine Agriculturist, **29**, 555 (1940).

connects the town of Binalonan and Asingan. The two major crops are palay and mungo. The problem of irrigation facilities is being remedied at present with the construction of an irrigation system to be fed by the Ambuklao Dam.

THE FARMERS

Tenure. More than one-half of the farmers interviewed were tenants. Only about one-fifth were part-owners and the same number were owners (table 1).

TABLE 1.—*Characteristics of farm operators*

ITEM	AVERAGE			
	Owner	Part-Owner	Tenant	All Farms
Number of farmers	24	25	68	117
Age of farmers	40	42	42	42
Education:				
Years of schooling	5.7	4.1	3.8	4.2
Size of farmer's household	4.7	4.7	4.6	4.6
Farmer's time:				
Months worked on farm	5.5	5.0	5.1	5.2
Months worked off farm	1.5	1.5	1.1	1.2
Months not gainfully employed	5.0	5.5	5.8	5.6

Age. In this particular area, the owners were two years younger than the tenants and part-owners, quite contrary to the general trend.

Education. The owner-operators although two years younger had more years of schooling than the part-owners and tenants. It is interesting to note that educational attainment was closely associated with the ownership status. Part-owners spent more years in school than full tenants, and full owners attained a higher level of schooling than part-owners.

Only a small percentage of the farm operators had high school and college education. About one-third had no formal education; one-fifth went to primary schools and two-fifths, to intermediate schools. More and better education would facilitate the introduction of modern production methods which would bring about a higher net farm income.

Size of operator's household. Each household regardless of tenure had almost the same number of individuals.

Use of operator's time. 1. Months worked on farm.—The owner-operator's labor input on the farm averaged 5.5 months yearly, slight-

ly higher than tenant's and part-owner's labor input, although part-owners had larger farms. This may be attributed to the higher educational attainment of owner-operators and possibly to the incentive given by land ownership.

2. *Months worked off farm.*—The owner-operator's and part-owner-operator's off-farm work averaged 1.5 months while that of the tenants only 1.1 months. The higher educational attainments of the farmers probably induced them to supplement their farming income to have a better standard of living. The average months worked off farm were 1.2 for all farms. Apparently farmers found little opportunity to increase their income by off-farm labor, possibly because of the absence of a local industry. The most common source of off-farm labor income was work as farm laborers in harvesting, threshing, plowing, and harrowing.

3. *Months not gainfully employed.*—For almost six months the farmers were not working. This was mainly due to the seasonal characteristics of crop-farming. Diversification or intensification of farming may help solve this problem.

THE FARMS

Type of farming. All farms were classified according to the principal source of gross farm income. The major source of gross farm income for two-thirds of the farms was palay raised during the wet season (table 2). Fourteen operators received most of their income from a combination of palay (wet season) and mungo. Twenty-nine farms had a greater diversification of farming enterprises and were classified as having no specialization.

TABLE 2.—*Types of farming*

TYPE OF FARMING	NUMBER OF FARMS			
	Owner	Part-Owner	Tenant	Total
Lowland: Palay, wet season	12	22	40	74
Combination: Palay and mungo	3	2	9	14
No specialization	9	1	19	29

The average gross farm income derived from palay (wet season) in the specialized farms was 62 per cent; from those combining palay and mungo, 47 per cent; and from those having no specialization, 37 per cent (table 3). The average for all farms was 54 per cent.

TABLE 3.—*Types of farming and degree of specialization*

TYPE OF FARMING	AVERAGE GROSS FARM INCOME DERIVED FROM PALAY BY TENURE			
	Owner	Part-Owner	Tenant	All Farms
	%	%	%	%
Lowland: Palay, wet season [a]	62	62	62	62
Combination: Palay and mungo [b]	47	46	48	47
No specialization [c]	33	42	39	37
Average	49	60	54	54

[a] Specialized farming—where any one enterprise or crop provides at least 51 per cent of the gross farm income.

[b] Combination—where any two crops or enterprises provide at least 67 per cent of the gross farm income (no single enterprise provides at least 51 per cent of gross income).

[c] No specialization—no major crop provides at least 51 per cent of gross farm income and no combination of two crops provides at least 51 per cent of the gross farm income.

Most of the farms classified under no specialization were those which had relatively small area and low yield.

Land-use. Palay and mungo were the most common crops grown. Some farmers also grew coconuts, bananas, eggplants, etc., and fruit trees such as starapple, jackfruit, citrus, papaya, pineapple, etc. (table 4). Most of the produce were used by the farmers' household.

TABLE 4.—*Utilization of farm area*

NAME OF CROP	NUMBER OF FARMS	HA. TREES OR PLANTS PER FARM	AVERAGE YIELD PER HECTARE	AVERAGE GROSS INCOME PER FARM
Palay, wet season	117	1.13 [a]	50	604
Mungo, dry season	117	1.13 [a]	7	246
Coconut	9	0.50 [a]	561	11
Bananas	33	13 [b]	11 [c]	18
Eggplant	17	107 [b]	16 [d]	15
Ampalaya	8	22 [b]	346	4
Other vegetables	7	—	—	3
Other fruits	19	—	—	32

[a] Ha. [b] Plants. [c] Bunches. [d] Crates.

Amount and value of land. The part-owners had the most cropland among types of operators (table 5). The tenants had the least, 0.57 hectare less than the part-owners.

Only two farmers reported land on woods and pasture, an average of 0.62 hectare per operator, valued at ₱2,080 per hectare.

TABLE 5.—*Characteristics of farms by tenure*

	OWNER	PART-OWNER	TENANT	ALL FARMS
Number of farms	24	25	68	117
Hectares per farm:				
Cropland	1.28	1.59	1.02	1.20
Farmstead	0.29	0.25	0.18	0.22
Effective crop area	2.38	3.02	1.94	2.26
Value per farm (₱):				
Cropland	3,158	3,884	2,533	2,949
Farmstead	608	602	560	579
Value per hectare (₱):				
Cropland	2,468	2,443	2,483	2,461
Farmstead	2,095	2,409	3,111	2,661

Of the 1.20 hectares of cropland, 1.13 hectares were double cropped thus increasing the operator's effective cropland to 2.26 hectares. A second crop gave farmers an opportunity to utilize their land and labor more effectively.

Land values given by the operators were almost the same regardless of the operator's tenure.

The value of the tenant operators' farmstead was relatively high per hectare. It was ₱3,111 or ₱450 over the average for all farms, ₱702 more than the part-owners and ₱1,016 more than the owners' value of farmstead per hectare. However, the size of the farmstead is relatively small and the average values of cropland and farmstead for all farms were almost the same.

Yield and return per hectare from double cropping palay and mungo. Double cropping of palay and mungo is the common cropping system in this barrio. All farmers practice this rotation. Mungo is grown after wet season rice is harvested (table 6).

TABLE 6.—*Yield and return per hectare from double cropping palay and mungo in 117 farms*

TENURE	CAVANS PER HA.		VALUE OF CROPS PER HA. IN PESOS		
	Palay, wet season	Mungo, dry season	Palay, wet season	Mungo, dry season	Total
Owner	50	7	499	214	713
Part-owner	52	7	516	203	719
Tenant	50	7	500	202	702
Average: All farms	50	7	503	205	708

Wag-wag and Raminad were the only varieties of palay grown in the locality. The average Wag-wag yield per hectare was 49 cavans while for Raminad it was 51 cavans. The average price per cavan was ₱10.13 for Wag-wag and ₱9.94 for Raminad. The gross return per hectare from Raminad averaged ₱506.95 which was ₱10.58 more than the gross return from Wag-wag. This may account for the preference of farmers for Raminad as the majority of farmers planted this variety.

Only the green variety of mungo was grown. The average yield per hectare of mungo was 7 cavans. The average price per cavan was ₱29.30. There was no difference in the yield per hectare by tenure of operation from palay and mungo.

The average receipts per hectare for all farms was only ₱205 from mungo and ₱503 from palay making a total of ₱708. There was little difference in the income per hectare among the different types of farm holdings.

The receipts per hectare can be increased if two crops of palay are grown yearly. This can be made possible only with irrigation facilities. However, if the increase of production from two crops of palay will merely compensate the cost of irrigation, double cropping of palay and mungo would probably be better because the land benefits from the remains of the mungo plants.

Livestock kept by farm operators. Almost 90 per cent of the farm operators owned a carabao. Very few farmers used cattle as work animals. Other livestock kept by them were hogs, poultry, horse, and goat.

Tenure arrangement. The tenure arrangement involved the sharing and disposal of products from 68 tenant-operations. For palay crops the landlord contributed one-half of the seed, one-half of the harvester and thresher's share and none for cash expenses (table 7). When these were deducted from his gross share, his net share represented his compensation for land use. In the case of mungo the landlord contributed nothing but the land; nevertheless, he got 33 per cent of the crop.

The sharing of the crops was on the 50:50 basis for rice and 1/3:2/3 for mungo. This was a rather unfair division of the crops for the tenant as he supplied all the labor, work animals, tools and equipment, and other deductible expenses.

TABLE 7.—*Sharing and disposal of palay in 68 tenant farms by size*

ITEM	CROPLAND PER FARM		
	0.1-0.75	0.76-1.25	1.26 & above
		cavans	
Seed	0.5	0.8	1.8
Harvester and thresher's share	4.0	7.3	17.1
Landlord's net share	9.2	16.7	45.3
Operator's net share:			
Consumed	9.2	14.6	29.1
Sold	—	2.1	16.1
Total production	22.9	41.5	109.9
		per cent	
Seed	2	2	2
Harvester and thresher's share	18	18	16
Landlord's net share	40	40	41
Operator's net share	40	40	41
Total production	100	100	100

The harvester's share was 16 to 18 per cent of the gross yield. On the small tenant farms the operator's net share of palay was consumed entirely by the operator's family. A small quantity was sold by tenants on medium-sized farms, while 61 cavans per farm were sold by tenants operating 1.25 or more hectares of cropland.

Landlord and tenant's contributions relative to their returns in 68 tenant palay operations.—Is 50:50 sharing of palay in the area equitable? The following analysis is an attempt to answer this question.

Cost for land use was computed at 12 per cent of the market value. The charge was based on the average return to landlord's capital in the area. Since the land was planted to mungo following the palay crop, it was assumed that only 70 per cent of the land cost should be charged to palay production.

Land tax, which is one per cent of the assessed value was computed at 0.3 per cent of the market value. This was found to be the rate of taxation by owners and part-owners in most studies conducted at the Department of Agricultural Economics. Again, only 70 per cent of the tax was charged to palay.

The cost for the use of work animals, tools, and equipment was computed at 12 per cent interest. Depreciation was not charged due to the difficulty of arriving at a reasonable figure. The cost of repair

of tools was included. Since the work animals, tools, and equipment were not used in mungo production, all this cost was fully charged to palay.

Seeds, harvester's and thresher's shares were charged at actual values to the contributing parties.

Seventy per cent of all labor and other expenses were charged to palay.

The operators valued this labor at ₱78 per month and the family labor at ₱60 per month. This valuation was accepted as a basis for computing the value of the operators' and family farm labor because it was in line with wages received for non-farm labor by these farmers. However, in view of the short period, about 1.5 months of the operators' non-farm employment, the value of farm labor seems high. One must keep in mind when one looks at the amount of ₱432 charged for operators' and family labor and at the tenants contribution-return difference of ₱270, the apparent loss in the tenant's farm operation. There would have been no loss if family farm labor had been valued at ₱30 to ₱40 which was found to be the accepted valuation in other areas rather than at ₱60 to ₱78, the rate per month in this study.

The question posed in the beginning of this discussion can now be answered. The landlord received a liberal return at 12 per cent on the high market value of his land, nearly ₱2,500 per hectare. In terms of the contribution-return difference he was overshared by 19 per cent. The tenant was shortshared by the same percentage.

From the foregoing charges, the tenant contributed more than two-thirds of the cost of production. But he received only one-half of the returns. He was shortshared 19 per cent. This explains why he had a bigger loss.

If all other expenses of the landlord contribution except land were paid first from the total returns, ₱208 would remain; only ₱13 more than the ₱195 charged for land alone. And if all other expenses of the tenant except his and his family labor were paid, only ₱162 would remain; ₱270 short of the ₱432 charged for the operator and family labor alone (table 8).

THE FARM BUSINESS

Capital invested. The part-owners had the biggest capital investment per farm. It averaged ₱5,984 of which 60 per cent was owned by the part-owner (table 9). The tenants had the least capital

TABLE 8.—*Landlord-tenant contributions and returns from 68 farms, palay only*

ITEM	PESOS		PER CENT	
	Landlord	Tenant	Landlord	Tenant
Contributions:				
Land	195	—	25	—
Land tax	5	—	1	—
Work-animals	—	25	—	3
Tools and equipment	—	19	—	2
Seeds	4	4	1	1
Harvester and thresher's share	34	34	4	4
Hired labor	—	6	—	1
Operator and family labor	—	432	—	57
Other expenses	—	1	—	[a]
Total contributions	238	521	31	69
Total returns	251	251	50	50
C–R difference [b]	+13	−270	19	−19
Share for land only	208	—	41	—
Share for operator and family labor	—	162	—	32

[a] Less than 0.5 per cent.
[b] C–R difference means contribution–returns difference, computed by subtracting contributions from returns.

TABLE 9.—*Average capital investment per farm*

ITEM	CAPITAL IN PESOS			
	Owner	Part-owner	Tenant	All farms
Land:				
Operator	3,766	2,113	560	3,529
Landlord		2,375	2,533	
Dwelling	1,095	931	755	862
Other buildings	40	32	3	17
Work animals	204	184	206	201
Other livestock	111	108	74	89
Tools and equipment	165	193	164	170
Supplies:				
Operator	40	43	26	36
Landlord	—	5	4	
Total	5,421	5,984	4,325	4,904
Per cent owned by operator	100	60	41	

investment per farm, ₱4,325 of which he owned 41 per cent. The tenant's capital was invested in his farmstead, dwelling, and other buildings, work animals and other livestock, and supplies.

The highest capital investment per farm was in land. Investment in dwellings was next highest while that in other buildings was very insignificant. Only 13 farmers reported having other buildings.

Gross receipts. The highest gross receipts per farm were registered by the part-owners (table 10). This may have been due to the bigger farms they operated. The tenants on account of the small farms they cultivated had only ₱634. This was ₱341 less than that of the part-owners. The owners received only ₱61 less than the part-owners.

TABLE 10.—*Farm capital, receipts, and expenses*

	OWNER	PART-OWNER	TENANT	ALL FARMS
Farm capital owned by operator in per cent	100	60	41	
Farm receipts:				
Livestock and products sold	₱ 58	₱ 46	₱ 42	₱ 46
Value of shares in kind for services	163	164	91	122
Value of crops to landlord		319	297	241
Crops sold	514	325	126	248
Buildings sold or rented	12	2	2	4
Increase in inventory	34	4		2
Operator's non-farm income	123	115	76	94
Total receipts	₱914 [a]	₱975	₱634	₱759 [a]
Farm expenses:				
Livestock bought	₱ 30	₱ 23	₱ 19	₱ 22
Value of crops to landlord	—	319	297	241
Value of share in kind for services	163	164	91	122
Cash expenses [b]	175	52	38	66
Value of unpaid family labor	271	331	382	348
Decrease in inventory	—	—	10	—
Total expenses	₱649 [a]	₱889	₱837	₱801 [a]
Net farm income	265	86	−203	−42

[a] Only 2 owner-operators reported crops to landlord, averaging ₱10 per owner-operator and ₱2 per farm (all farms).

[b] Includes buildings and tools bought, hired animal and man labor.

Gross farm expenses. The part-owners incurred the highest gross farm expenses per farm. This was again probably due to the larger areas they cultivated. The tenants in spite of the smaller areas cultivated had the second highest gross farm expenses. This

was probably because they overestimated the value of unpaid family labor and because their expenses included the full charge for land use or value of crops given to landlord. In the case of the owner the charge for land use was not introduced until the interest on capital was deducted.

The owners had the smallest expenses primarily because they had no "value of crops to landlord".

Net farm income. The owner-operators averaged ₱265 net farm income per farm, the highest for all types of operators. The part-owner operators although having the biggest farm got only ₱86 because of their relatively high gross farm expenses and the high value of unpaid family labor (table 11). The tenants in general were the most miserable group of farm operators as indicated by their net loss of ₱203. The net farm income represents the operator's return after deducting the overall costs of farm operation from the gross receipts. It is the return to the farm and to the farmer. Because of the inequality in charging land use, net farm income is not a good measure where differences in ownership exist.

Operator's labor income. Regardless of tenure all operators received negative labor income. This amount represents the compensation of the operators after deducting 12 per cent interest on average capital share of operators from the net farm income. Labor income is not an adequate measure where farmers consume a large share of their produce.

TABLE 11.—*Measures of success*

ITEM	OWNER	PART-OWNER	TENANT	ALL FARMS
Net farm income	₱ 265	₱ 86	₱−203	₱−42
Interest on average inventory	642	432	225	360
Operator's labor income	−374	−344	−426	−398
Farm privileges:				
Use of dwelling	109	93	75	88
Livestock and products used	5	4	6	5
Rice used at home	310	234	154	188
Other crops used at home	44	47	32	38
Operator's labor earning	12	−15	−154	−90
Other income:				
Interest on average inventory	648	432	225	360
Unpaid family labor	271	331	382	348
Other family non-farm income	379	240	277	290
Amount available for family living	₱1,310	₱988	₱730	₱908

Farm privileges. The tenants had the least farm privileges. Again this was probably due to the small area operated. The part-owners and owners had almost equal farm privileges.

Operator's labor earning. This amount represents the operator's labor income plus the farm privileges. Only the owner operators received a positive labor earning. All other types of operators received negative labor earning. This is explained mainly by the high charge for unpaid family labor and the relatively high rate of interest. These two items are merely imputed charges and not cash expenses.

Amount available for family living. This amount represents the income from all sources which is available to the family for living and saving. It includes the farmer's labor income, interest on his investment, unpaid family labor, and income from family non-farm employment. In this study, the owner operators had the most amount available for family living because they owned their capital. The tenants who owned 41 per cent of their total capital got only ₱225 interest on capital, and although they had the highest value of unpaid family labor, they had the least amount available for family living.

FACTORS AFFECTING SUCCESS IN FARMING

Ownership of farm may be a factor that contributes to success in farming. Other factors may be schooling and size of business.

Relation of farm size to operator's labor input. There was a remarkably small variation in the labor input by size of farm. The larger farm operators accomplished the work in almost the same amount of time as the small operators. With few alternative opportunities for the use of labor, as shown by the larger number of months of unemployment, there was little incentive for efficiency in the use of labor (table 12).

TABLE 12.—*Relation of farm size to operator's labor input*

ITEM	CROPLAND IN HA.		
	0.1-0.9	1.0-1.9	2.0 & above
Number of farms	52	52	13
Months worked on farm	5.1	5.0	5.9
Months worked off farm	1.7	1.0	1.8
Months not gainfully employed	5.2	6.0	4.3
Income from off-farm labor	₱122	₱60	₱115

The little more time spent by large farm operators on the farm was carried over into their non-farm employment to the extent that they were the highest of the three groups in amount of time spent. However, this did not indicate that an increase in off-farm work brought about a corresponding increase in off-farm income.

Relation between experience in farming and size of cropland. There was a general tendency for the size of the cropland to increase with the years of experience in farming (fig. 1). However, the upward trend was reversed as the operators reached an experience of 41 years and above. This can be explained by our inheritance tradi-

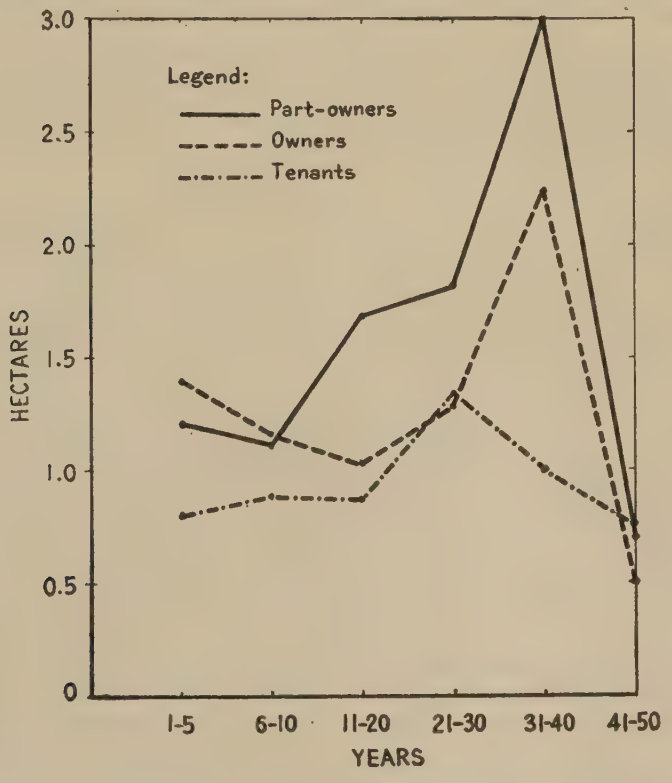

Fig. 1.—Relationship between experience in farming and size of cropland by tenure status.

tion under which our land is subject to "continuous parcelation." Following this tradition an operator, after having farmed for about 40 years, might have a son or a daughter, or two, married, and feel obliged to give these children part of his land to cultivate. The landlord might have the same situation with his children. In either case the landholdings are reduced in size.

Another explanation is the probability that landlords may transfer land from old tenants to younger ones as the older ones become less physically able to farm.

Part-owners have the largest farms and the highest rate of cropland increase because they are utilizing landlord's capital in addition to their own. The tenants because of their small farms have small incomes which give them little opportunity to increase the size of business.

Relation between operator's education and net farm income. Education had a positive relation with net farm income. As the education of operators increased, net farm income also increased. This was probably due to the desire of the more educated farmers for a better standard of living. Those with higher educational attainment possibly practised a better method of culture, through preparation of land and selection of good seeds.

Labor efficiency. The land force per farm, stated in man-equivalent, showed little difference between small, medium, and large farm (table 13). However, labor input in man-equivalent per hectare declined as the farm size increased. Labor contributed by farmers' children below 14 years was excluded in the computation for man-equivalent.

TABLE 13.—*Labor efficiency*

SIZE (HA.)	LABOR INPUT IN MAN-EQUIVALENT		CAVANS PRODUCED PER MAN-EQUIVALENT
	Per farm	Per hectare	
0.1–0.9	0.95	1.69	28
1.0–1.9	0.93	0.84	65
2.0 and above	1.08	0.33	124
All farms	0.95	0.85	56

In small farms labor was not used effectively. The average cavans produced per man-equivalent was only 28 as compared with the medium farm which had an average of 65 cavans per man equivalent, and the big farm which had the highest, 124 cavans per man-equivalent.

What can be produced in the big farm cannot be produced in the small farm because of the interaction of the law of "marginal productivity". If the land has reached its marginal capacity to produce, no amount of labor input can increase the output. Therefore,

the best way to increase production efficiency is to increase the land cultivated. This was partially accomplished by double cropping.

If only one crop-system was used, the return per hectare would have been only ₱503. With the practice of double cropping palay and mungo, the effective cropland increased to 2.26 hectares and receipts per hectare to ₱708 (table 6).

Landlord's return from 68 tenant operations. The landlord's return to capital was only 7.1 per cent which was very low compared with the return to capital in industry (table 14). However, the landlord's net share for the land was very high, almost 36 per cent of the total receipts per hectare.

TABLE 14.—*Landlord's return from 68 tenant operations*

CROP	NUMBER	LANDLORD'S NET SHARE FOR LAND	LANDLORD'S RETURN PER HECTARE	LANDLORD'S RETURN TO CAPITAL
		%	₱	%
Double cropping:				
Palay		41		
and	68		252	7.1
Mungo		33		

The landlords might have been better off if they had sold their land at market price and invested their capital in more profitable ventures but because the return per hectare was very high compared with the market value of the land he was still at an advantage. Other likely reasons why landlords did not withdraw their capital on land were (1) probable ignorance of other opportunities for investments, (2) tradition and prestige—there is pride in ownership of land, (3) risk and lack of industrial and business know-how.

Relation of yield and size of cropland to net farm income. The net farm income was greatly affected by the size of cropland and the rate of crop production. As the size of farm and yield increased the net farm income also increased (table 15).

TABLE 15.—*Relation between yield and size of cropland to net farm income*

YIELD PER HECTARE	AVERAGE NET FARM INCOME (₱)	
	Farm below 2.0 Ha.	Farm above 2.0 Ha.
Below average, less than 50 cavans	−164	456
Above average, 50 cavans and above	−72	770

In table 15 the farms were classified into size groups. Farms below 2 hectares formed the size group and farms above 2 hectares formed another group. To see the combined effect of yield per hectare and size of cropland to net farm income the two size groups were split according to yield per hectare.

Yield was negatively related to income on the larger farms. Farm size was clearly associated with net farm income. Where both yield and size were below average income was lowest. Conversely, both yield and farm size were positively associated with net farm income. The combined effect of high yield and farm size produced the highest income.

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As the arts and crafts develop and become more elaborate, the body of positive and tested knowledge enlarges, and the sequence observed become more complex and of greater scope. Technologies of this kind give that common-sense knowledge of nature out of which science takes its origin. They provide not merely a collection of positive facts, but they give expertness in dealing with materials and tools, and promote the development of the experimental habit of mind, as soon as an art can be taken away from the rule of sheer custom.

—*John Dewey*

DIGESTIBILITY OF RICE STRAW ALONE AND IN A BALANCED RATION BY PHILIPPINE STEER, GRADE AND PURE MURRAH CARABAO, AND HOLSTEIN CATTLE [1]

ANTONIO S. ACHACOSO

There was a highly significant difference in the digestibility of the organic matter, protein, fat and nitrogen-free-extract contents of the rations. The digestibility of fiber in the different rations which did not vary significantly was decreased with the addition of concentrates.

Negative values for protein and fat were obtained in the digestibility of rice straw by the difference method. These may have been due to the associative effect of the concentrates when added to rice straw which is low in protein and fat contents.

Morrison [2] reported that the percentage composition of rice straw is as follows: protein, 3.9; fat, 1.4; fiber, 33.5; nitrogen-free extract, 39.2; ash, 14.5; calcium, 0.19; phosphorus, 0.07; digestible protein, 0.6; and total digestible nutrients, 41.5.

Schneider [3] studied the composition and digestibility of rice straw for cattle both by the direct and the difference methods. His summary follows:

	COMPOSITION		DIGESTION COEFFICIENT	
	I	II	Difference	Direct
Protein	2.6	3.3	2	9
Fat	0.8	1.1	44	44
Fiber	30.4	29.6	66	62
Nitrogen-free extract	44.1	41.7	54	46
Ash	15.9	12.3	—	—
Digestible protein	0.1	0.3	—	—
Total digestible nutrients	44.7	88.9	—	—
Organic matter	—	—	57	51

[1] Central Experiment Station Contribution No. 1904. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1955. Prepared in the Department of Animal Husbandry under the direction of Dr. John K. Loosli, former visiting Cornell professor.

[2] F. B. Morrison, "Feeds and Feeding," Morison Publishing Co., Ithaca, N. Y., 1951.

[3] B. H. Schneider, "Feeds of the World," West Virginia Experiment Station, Morgantown, West Virginia, 1947.

Since studies of this nature have not been made in the Philippines, this study was conducted from November, 1953, to July, 1954, to determine the comparative digestibility of rice straw when fed alone and in a balanced ration to cattle and carabaos.

MATERIALS AND METHODS

Philippine steer, Grade Murrah carabao, Murrah Carabao, Holstein bull, and Holstein cow of about the same age were used in this study.

The rations used were:

Ration A—Rice straw and salt.
Ration B—Rice straw, 63 per cent; copra meal, 35 per cent; shells, 1 per cent; and salt, 1 per cent.
Ration C—Rice straw, 55 per cent; copra meal, 35 per cent; molasses, 8 per cent; shells, 1 per cent; and salt, 1 per cent.
Ration D—Rice straw, 68 per cent; ipil-ipil soilage, 8 per cent; copra meal, 12 per cent; molasses, 10 per cent; urea, 1 per cent; and salt, 1 per cent.

The animals were placed in digestion stalls and were fed the rations during the different periods of study using the 4 × 4 Latin square. The concentrates were consumed first before rice straw was given. Fresh water was made available any time the animals needed it.

A two-week preliminary period on each ration with constant daily feed intakes for each animal was conducted before fecal collections were made to make sure that these fecal residues came from the rations given. Dried and composited samples of the forages were saved for analysis. The small amounts of orts obtained were weighed, sampled, and corrected for moisture contents. The daily feces were collected for 10 days in tin containers, weighed, and mixed separately at the same hour each day. Two per cent of the total feces dried under infrared lamps was composited, ground, and kept in sealed mason jars for chemical analysis. Five-tenths per cent of the urine of the Philippine steer preserved in toluene was likewise saved for analysis. The value obtained in this analysis together with the protein analysis of the feed taken in, and the feces voided out, provided a quantitative measure of the protein metabolism, and showed whether the body was gaining or losing protein. The amount of nitrogen given out or

retained daily was obtained by subtracting the amounts of nitrogen excreted in the feces and urine from the total nitrogen intake. Samples of the different concentrate mixtures were also saved for analysis.

The animals were weighed at the beginning and end of each collection period to find out any increase or decrease in body weights.

RESULTS AND DISCUSSION

Chemical analysis. The chemical composition of rice straw, ipil-ipil soilage, and the concentrates used in this study are given in table 1. A comparison of the chemical composition of rice straw in this study and data reported by Morrison [4] and Schneider [5] follows:

TABLE 1.—*Chemical analysis in per cent of the feeds as fed*

FEED	SAMPLE NO.	MOISTURE	CRUDE PROTEIN	CRUDE FAT	CRUDE FIBER	N.F.E.	ASH
	158	25.01	3.14	1.96	23.68	27.65	18.56
	235	18.30	3.20	2.00	27.93	33.14	15.43
Rice straw	277	16.64	3.68	1.05	28.92	32.68	17.03
	355	16.90	2.54	1.70	28.14	32.49	18.23
Mean		19.22	3.14	1.68	27.17	31.49	17.31
	166	70.77	7.96	1.59	5.44	12.07	2.17
	236	70.97	8.40	1.66	5.31	11.22	2.44
Ipil-ipil soilage	276	70.90	8.08	1.13	5.24	12.44	2.21
	336	73.76	7.90	1.25	4.71	10.66	1.83
Mean		71.57	8.09	1.41	5.17	11.60	2.16
	181	4.88	22.89	7.74	8.52	49.15	6.82
Concentrate B [a]	291	6.78	22.18	7.19	11.31	44.94	7.60
Mean		5.83	22.54	7.47	9.92	47.05	7.21
	160	15.33	16.34	5.45	9.04	45.58	8.26
Concentrate C [b]	318	12.64	15.15	5.00	7.75	50.20	9.26
Mean		13.99	15.75	5.23	8.40	47.89	8.76
	161	20.19	19.70	2.66	4.98	43.43	9.04
Concentrate D [c]	319	18.17	22.81	2.49	4.83	42.14	9.02
Mean		19.18	21.26	2.58	4.91	42.79	9.03
Molasses	168	22.58	1.10	1.30	—	67.16	7.86

[a] Contained 95 per cent copra meal, 2.5 per cent shells, and 2.5 per cent salt.
[b] Contained 78 per cent copra meal, 18 per cent molasses, 2 per cent shells, and 2 per cent salt.
[c] Contained 50 per cent copra meal, 42 per cent molasses, 4 per cent urea, and 4 per cent salt.

[4] Morrison, *op. cit.*
[5] Schneider, *op. cit.*

COMPOSITION	PROTEIN	FAT	FIBER	N.F.E.	ASH
This study	3.1	1.7	27.2	31.5	17.3
Morrison	3.9	1.4	33.5	39.2	14.5
Schneider	a. 2.6	0.8	30.4	44.1	15.9
	b. 3.3	1.1	29.6	41.7	12.3

This shows that the values obtained were higher for fat and ash, lower for fiber and nitrogen-free extract, and about midway for protein.

Digestion coefficients. The digestion coefficients of the rations computed by the direct method were significantly different in digestibility of organic matter, protein, fat, and nitrogen-free extract but not of fiber (table 2). The organic matter, fat, and nitrogen-free extract contents of ration B were highly digestible, followed by those

TABLE 2.—*Digestion coefficients of the rations computed by direct method*

Animal	O.M.	Protein	Fat		N.F.E.
RATION A					
Holstein cattle	48.9	3.3	29.2	61.4	42.7
Grade Murrah carabao	48.9	16.4	27.4	61.6	42.7
Murrah Carabao	42.8	6.4	3.5	60.2	33.6
Philippine Steer	45.7	13.1	39.1	59.2	37.2
Mean	46.6	9.8	24.8	60.6	39.1
RATION B					
Holstein cattle	56.7	58.6	87.0	54.4	54.4
Grade Murrah Carabao	67.7	70.6	86.0	60.6	68.8
Murrah Carabao	58.5	60.3	82.2	52.3	59.1
Philippine Steer	57.4	55.6	78.0	56.1	56.4
Mean	60.1	61.3	83.3	55.9	59.7
RATION C					
Holstein cattle	54.0	64.3	79.0	40.6	55.1
Grade Murrah Carabao	64.4	64.1	74.9	61.9	64.9
Murrah Carabao	65.3	64.9	80.3	56.9	67.1
Philippine Steer	49.0	54.6	79.4	44.6	48.6
Mean	58.2	62.0	78.4	51.0	58.9
RATION D					
Holstein cattle	55.0	64.7	46.7	50.9	55.6
Grade Murrah Carabao	49.2	57.4	42.7	50.3	46.6
Murrah Carabao	62.6	69.0	57.7	65.1	59.5
Philippine Steer	55.8	65.2	49.3	50.4	56.2
Mean	55.7	64.1	49.1	54.2	54.5

of rations C, D, and A; for protein, ration D, followed by rations C, B, and A; and for fiber, ration A, followed by rations B, D, and C. These can be explained by the fact that as the nutritive ratio becomes wider, the digestibility of all the nutrients particularly protein, tends to be lower. This effect is explained on the basis of metabolic nitrogen output, since the protein coefficient determined represents the apparent digestibility. Also, the addition of cane molasses and other easily-digested carbohydrates to a ration reduces the digestibility of fiber because the bacteria in the digestive tract which normally digest fiber attack the more readily available starches or sugars.

There was no significant difference in the digestion coefficients of the animals used (table 3). Ranked according to digestion effi-

TABLE 3.—*Digestion coefficients of the animals computed by direct method*

Ration	O.M.	Protein	Fat	Fiber	N.F.E.
		HOLSTEIN CATTLE			
A	48.9	3.3	29.2	61.4	42.7
B	56.7	58.6	87.0	54.4	54.4
C	54.0	64.3	79.0	40.6	55.1
D	55.0	64.7	46.7	50.9	55.6
Mean	53.7	47.7	60.5	51.8	52.0
		GRADE MURRAH CARABAO			
A	48.9	16.4	27.4	61.6	42.7
B	67.7	70.6	86.0	60.6	68.8
C	64.4	64.1	74.9	61.9	64.9
D	49.2	57.4	42.7	50.3	46.6
Mean	57.6	52.1	57.8	58.6	55.8
		MURRAH CARABAO			
A	42.8	6.4	3.5	60.2	33.6
B	58.5	60.3	82.2	52.3	59.1
C	65.3	64.9	80.3	56.9	67.1
D	62.6	69.0	57.7	65.1	59.5
Mean	57.3	50.2	55.9	58.6	54.8
		PHILIPPINE STEER			
A	45.7	13.1	39.1	59.2	37.2
B	57.4	55.6	78.0	56.1	56.4
C	49.0	54.6	79.4	44.6	48.6
D	55.8	65.2	49.3	50.4	56.2
Mean	52.0	47.1	61.5	52.6	49.6

ciency grade Murrah carabao was first in the digestibility of organic matter, protein, fiber and nitrogen-free extract, followed by Murrah carabao, Holstein cattle and Philippine steer. In the digestibility of fat, Philippine steer ranked first, followed by Holstein cattle, grade Murrah carabao, and Murrah carabao.

To estimate the digestibility of rice straw alone in rations B, C, and D by the difference method, the average digestion coefficients for the concentrates reported by Schneider [6] and those for alfalfa reported by Morrison [7] were used to correct the fecal residue from the concentrates and ipil-ipil. The values obtained on ration comparison and those on animal comparison were not treated statistically

TABLE 4.—*Digestibility of rice straw calculated by difference on ration comparison*

Animal	O.M.	Protein	Fat		N.F.E.
		RATION A			
Holstein cattle	48.9	3.3	29.2	61.4	42.7
Grade Murrah carabao	48.9	16.4	27.4	61.6	42.7
Murrah carabao	42.8	6.4	3.5	60.2	33.6
Philippine steer	45.7	13.1	39.1	59.2	37.2
Mean	46.6	9.8	24.8	60.6	39.1
		RATION B			
Holstein cattle	37.4	0 [a]	28.9	52.6	29.2
Grade Murrah carabao	59.9	39.4	61.9	60.1	60.5
Murrah carabao	41.3	0	39.5	49.9	39.7
Philippine steer	40.8	0	20.8	54.7	37.2
Mean	44.9	—	37.8	54.3	41.7
		RATION C			
Holstein cattle	19.2	0	23.2	32.8	13.7
Grade Murrah carabao	50.5	13.7	30.7	61.7	46.7
Murrah carabao	32.1	0	8.2	53.5	28.7
Philippine steer	8.5	0	0	38.1	0
Mean	27.6	—	—	46.5	—
		RATION D			
Holstein cattle	34.5	34.8	19.6	50.4	31.3
Grade Murrah carabao	29.4	6.6	0	49.9	20.3
Murrah carabao	51.9	54.4	42.7	66.8	44.9
Philippine steer	36.4	32.5	22.1	49.9	33.3
Mean	38.1	32.1	28.1	54.3	32.5

[6] *Ibid.*
[7] Alfalfa is similar to our ipil-ipil.

because of the negative values obtained especially for protein (tables 4 and 5). These negative values were due to the associative effect of the concentrates which when added to rice straw either increased the digestibility of protein above 100 per cent, or decreased it to less than zero.

Nitrogen balance. In period I on ration A, Philippine steer lost 7.78 grams nitrogen daily (table 6). Since the ration could not meet the protein requirements the animal had to draw protein from the body, as evidenced by a decrease in body weight.

TABLE 5.—*Digestibility of rice straw calculated by difference on animal comparison*

Ration	O.M.	Protein	Fat	Fiber	N.F.E.
		HOLSTEIN CATTLE			
A	48.9	3.3	29.2	61.4	42.7
B	37.4	0.0 [a]	28.9	52.6	29.2
C	19.2	0	23.2	32.8	13.7
D	34.5	34.8	19.6	50.4	31.3
Mean	35.0	—	25.2	49.3	29.2
		GRADE MURRAH CARABAO			
A	48.9	16.4	27.4	61.6	42.7
B	59.9	39.4	61.9	60.1	60.5
C	50.0	13.7	30.5	61.7	46.7
D	29.4	6.6	0	49.9	20.3
Mean	47.1	19.0	—	58.3	42.6
		MURRAH CARABAO			
A	42.8	6.4	3.5	60.2	33.6
B	41.3	0	39.5	49.9	39.7
C	32.1	0	8.2	53.5	28.7
D	51.9	54.4	42.7	66.8	44.9
Mean	42.5	—	23.5	57.6	36.7
		PHILIPPINE STEER			
A	45.7	13.1	39.1	59.2	37.2
B	40.8	0	20.8	54.7	37.2
C	8.5	0	0	38.1	0
D	36.4	32.5	22.1	49.9	33.3
Mean	32.9	—	—	50.5	—

[a] Negative values are reported as zeros.

TABLE 6.—*Amount of nitrogen in grams retained or lost daily by Philippine steer*

AVERAGE DAILY INTAKE	PERIOD			
	I	II	III	IV
Intake	17.28	74.54	87.20	105.12
In feces	15.02	32.19	39.62	36.59
In urine	10.04	41.22	18.58	26.14
Amount retained daily	—7.78	—.87	29.00	42.39

In period II, although the animal was fed with ration D which was rich in protein, an average of 0.87 gram of nitrogen was lost daily because the amount taken in was still insufficient to meet the amount needed by the animal to recover from the effect of ration A in period I. When fed rations C and D in periods III and IV, the animal retained an average of 29.0 grams and 42.4 grams of nitrogen daily and thereby increased in weight.

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In the sharp formulation of the law of causality: "when we know the present with precision we can calculate the future," not the conclusion is wrong, but the premise. On principle we can not know the present in all its determining factors. Therefore all perception is a selection from a multitude of possibilities and a limitation of future possibilities.

—*Heisenberg*

THE NUTRITIVE VALUE AND PALATABILITY OF COMBINATIONS OF CORN AND MADRE DE CACAO (*GLIRICIDIA SEPIUM* STEUD.) SILAGE[1]

ROEL Z. ORTIGAS

WITH ONE TEXT FIGURE

Lot III (four-fifths corn and one-fifth madre de cacao) was richest in protein, nitrogen-free extract, and had the highest calorific value for every 100 grams of silage. The widest calcium-phosphorus ratio was contained in lot II (two-thirds corn and one-third madre de cacao). There were significant differences among the lots in feeding trial I but none in feeding trial II. Lot II which contained the greatest amount of madre de cacao leaves was relished more by the animals in both trials.

Madre de cacao (*Gliricidia sepium* Steud.), locally known as *kakawate,* is a legume that grows in most farm areas. Being a legume, it is assumed that it would increase the protein, calcium and vitamin contents of silage when mixed in proper proportions with corn. The difficulty of ensiling legumes, however, stems from their high protein content and lack of soluble carbohydrates which encourage excessive putrefaction (McCandish, 1922). Henderson and Reaves (1954) observed that the keeping of hay-crop silages may be ensured by mixing them with corn or sorghum. Esguerra (1948) succeeded in making good silage out of one part corn and 1.34 tapilan.

To compare the nutritive value and palatability of silage made from combinations of corn and madre de cacao, this study was conducted from July, 1954, to September, 1955.

MATERIALS AND METHODS

Chopped madre de cacao leaves and corn forage were weighed separately, mixed to desired proportions and put into the silos. Chopped corn forage (the control) was weighed before it was ensiled.

[1] Central Experiment Station Contribution No. 1905. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1955. Prepared in the Department of Animal Husbandry under the direction of Dr. Valente Villegas.

The silages were grouped into lots: lot I (pure corn); lot II (two-thirds corn and one-third madre de cacao); and lot III (four-fifths corn and one-fifth madre de cacao).

A large concrete pit with six compartments of about 1.08 cu. m. each was used for silos. The chopped materials were trampled to compress the forage evenly. Twenty kilograms of water was poured into each silo to insure sufficient moisture. No water was added in the last ensiling because corn at the dough stage was used and therefore was assumed to have enough moisture.

To reduce spoilage, dried rice straw was used to cover the surface, and stones were placed on top to weigh down the chopped material.

Ensiling was done three times. Trial I was from June 25, 1954, to August 25, 1954; trial II, from March 8, 1955, to May 26, 1955; and trial III, from August 6, 1955, to August 22, 1955. In the first ensiling, 212 kilograms of each kind of forage was placed in each silo; in the second, 250 kilograms; and in the last, 270 kilograms.

In trial I changes in temperature and the pH value of the silages were taken at depths of 40 cm. four weeks after ensiling and every week thereafter. In trial II, these were taken one week after ensiling, and in trial III, the readings were taken weekly for the first four weeks.

To determine how much of the silages would be consumed, the lots were fed to three Red Sindhi cows designated as Cow A, Gulmore, Cow B, Malir, Cow C, Kunijir. After the second feeding period of trial I, Vaña and Deli replaced Gulmore and Kunijir, because the latter were culled from the College dairy herd.

The silages were fed two months after ensiling, except for the silage ensiled last which was fed when it was two weeks old. The cows were kept in separate stalls, and were fed with the silages using the 3×3 Latin square from seven o'clock in the morning to four o'clock in the afternoon. The daily leftovers were weighed to determine the amount consumed daily.

The weights of the cows were taken before and after feeding of a different kind of silage. The averages of these weights were used to calculate the average daily consumption for every 100 kg. liveweight.

RESULTS AND DISCUSSION

Temperature changes. According to Henderson and Reaves (1954), the heat developed in the silage is caused by bacterial fermentation. They observed that the temperature continued to rise

for about 15 days and then gradually decreased as the silage aged. The temperature ranged from 80°F. to 130°F. (26.7°C. to 54.4°C.).

In this study, the average temperature of all silages ranged from 41.5°C. to 43°C., higher than those obtained by Vera Cruz (1951), and Agrupis (1953). The average temperature for the first week was 40.4°C., lower than that obtained by Catalan.[2] In lot I, the lowest temperature recorded was 32°C. and the highest was 50°C., thus averaging 43.1°C. The temperature in both lots II and III ranged from 34°C. to 51°C. The temperatures of the different silages, therefore, did not vary much. In contrast to previous findings, the temperature did not reach its peak on the second week but continued to rise up to the sixth and seventh weeks. The averages of the temperature during this period were 49.1°C. for lot I; 47.8°C. for lot II; and 45.5°C. for lot III. The temperature dropped gradually after this period (fig. 1 and table 1).

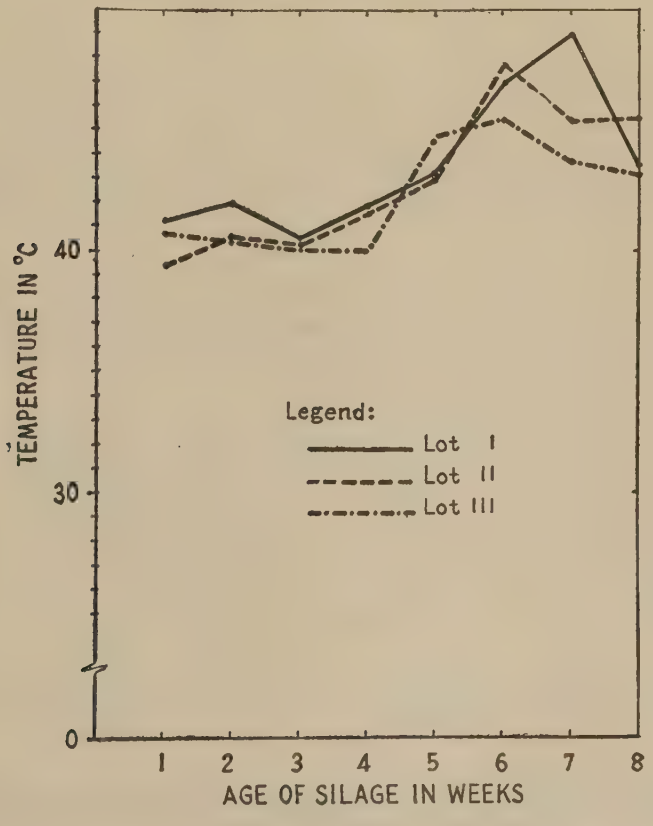

Fig. 1.—The average temperature of the silages

[2] M. V. Catalan. A study on the quality of silage made of different combinations of corn and Para grass. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, October, 1954. (Unpublished)

pH value. The most important change in the ensiled silage is the production of acid. A gram of silage juice may contain one hundred billion bacteria after two days (Morrison, 1948). In lot I, the lowest pH value observed was 3.5 and the highest was 6.45. In lot II, a pH value range of 3.62 to 6.42 was recorded; and in lot III, the pH fell between 3.71 and 6.32. The different silages had approximately the same pH values. The pH value of the three lots was highest in the beginning and decreased as the silage aged (table 1).

TABLE 1.—*Average pH and temperature readings of the silages*

TRIAL	PURE CORN		TWO-THIRDS CORN AND ONE-THIRD MADRE DE CACAO		FOUR-FIFTHS CORN AND ONE-FIFTH MADRE DE CACAO	
	Average		Average		Average	
	pH	Temp.	pH	Temp.	pH	Temp.
I	4.22	45.44	4.28	45.38	4.19	43.00
II	4.59	44.95	4.61	44.13	4.56	43.40
III	4.38	38.93	4.59	38.35	4.46	38.23
Mean	4.40	43.11	4.49	42.62	4.40	41.54

Proximate analysis. Based on the proximate analysis of the various silages, lot III had the highest total dry matter content of 56.48 per cent; next was lot II, 53.09 per cent; and lot I, 46.61 per cent.

The protein content of the silages with madre de cacao was higher than that of the pure corn silage. Lot III had 5.03 per cent; lot II, 4.87 per cent; and lot I, 3.57 per cent (table 2a).

TABLE 2a.—*Proximate analysis of the silages*

NUTRIENT	PURE CORN	TWO-THIRDS CORN AND ONE-THIRD MADRE DE CACAO	FOUR-FIFTHS CORN AND ONE-FIFTH MADRE DE CACAO
Moisture	53.39	46.91	43.52
Protein	3.57	4.87	5.03
Fat	0.87	1.19	1.32
Fiber	9.30	11.31	11.01
N.F.E.	26.44	24.60	27.19
Ash	3.31	5.37	4.59
Calorific value per 100 grams	131.14	131.89	157.90

All the percentages of nutrients were higher than those reported by Taleon *et al.* (1933), and Esguerra (1948).

Mineral contents. Lot II contained 0.66 per cent calcium and 0.38 per cent phosphorus, or a ratio of 1.7:1 (table 2b). The calcium content of lot III was 0.78 per cent, and its phosphorus content, 0.52 per cent, with a ratio of 1.5:1. Lot I contained 0.37 per cent calcium and 0.39 per cent phosphorus, a ratio of almost 1:1.

TABLE 2b.—*Mineral contents in per cent of the silages*

MINERALS	PURE CORN	TWO-THIRDS CORN AND ONE-THIRD MADRE DE CACAO	FOUR-FIFTHS CORN AND ONE-FIFTH MADRE DE CACAO
Calcium	0.37	0.66	0.78
Phosphorus	0.39	0.38	0.52

Lot II had the widest calcium-phosphorus ratio. In 1948, Morrison reported that good results were obtained by feeding rations containing a calcium-phosphorus ratio which ranged from 6:1 down to 0.6:1 to cattle.

Yield of silage. The average yield of silage for the entire experiment was 69.44 per cent. The highest percentage of yield which ranged from 57.17 to 85.04 or an average of 71.78 per cent was obtained from lot II (table 3). The low recovery of all the silages could be attributed to inefficiency of ensiling. The yield improved in the later part of the study, however, as the technique of the process was mastered.

TABLE 3.—*Amount of fresh forage used and yield of good silage in kilograms*

TRIAL	PURE CORN			TWO-THIRDS CORN AND ONE-THIRD MADRE DE CACAO			FOUR-FIFTHS CORN AND ONE-FIFTH MADRE DE CACAO		
	Fresh forage	Yield		Fresh forage	Yield		Fresh forage	Yield	
		Silage	Percentage		Silage	Percentage		Silage	Percentage
I	424	224.5	52.92	424	242.3	57.17	424	209.8	49.48
II	500	352.0	70.40	500	365.7	73.14	500	365.7	73.14
III	540	456.0	84.44	540	459.2	85.04	540	427.7	79.20
Average	488	344.16	69.26	488	355.73	71.78	488	334.40	67.27

Silage consumption. Villegas and Elepaño (1939) reported that Mellore cows consumed corn silage from 10.61 to 23.08 kilograms daily.

In this study, the cows consumed silage from 7.4 to 30.3 kilograms daily. In feeding trial I, the daily consumption for lot I

ranged from 8.7 to 18.0 kilograms; for lot II, 9.4 to 25.8 kilograms; and for lot III, 8.9 to 21.3 kilograms.

In feeding trial II, the daily consumption ranged from 7.4 to 26.8 kilograms for lot I; 9.5 to 27.6 kilograms for lot II; and 11.8 to 30.3 kilograms for lot III. The daily consumption in this trial were higher than those obtained in feeding trial I. The heaviest consumers of silage were cows B and C.

The average daily consumption of the different silages show that lot II was preferred by the animals to both lots I and III. Lot I was eaten least by the cows (tables 4a and 4b).

TABLE 4a.—*Average daily consumption and average daily consumption for every 100 kg. liveweight in feeding trial I*

COW	PURE CORN		TWO-THIRDS CORN AND ONE-THIRD MADRE DE CACAO SILAGE		FOUR-FIFTHS CORN AND ONE-FIFTH MADRE DE CACAO SILAGE	
	Av. daily consumption per head	Av. daily consumption per 100 kg. liveweight	Av. daily consumption per head	Av. daily consumption per 100 kg. liveweight	Av. daily consumption per head	Av. daily consumption per 100 kg. liveweight
A	13.62	4.67	15.54	5.33	13.46	5.27
B	12.67	5.12	18.52	5.71	16.44	5.06
C	13.71	5.13	15.99	6.26	13.96	5.25
Total	40.00	14.92	50.05	17.30	43.86	15.58
Average	13.33	4.97	16.68	5.77	14.62	5.19

TABLE 4b.—*Average daily consumption and average daily consumption for every 100 kg. liveweight in feeding trial II*

COW	PURE CORN		TWO-THIRDS CORN AND ONE-THIRD MADRE DE CACAO SILAGE		FOUR-FIFTHS CORN AND ONE-FIFTH MADRE DE CACAO SILAGE	
	Av. daily consumption per head	Av. daily consumption per 100 kg. liveweight	Av. daily consumption per head	Av. daily consumption per 100 kg. liveweight	Av. daily consumption per head	Av. daily consumption per 100 kg. liveweight
A	10.61	4.14	20.18	7.60	16.34	6.20
B	21.77	8.26	16.80	6.76	23.07	8.51
C	23.08	7.99	22.06	7.77	18.14	6.85
Total	55.46	20.39	59.04	22.13	57.55	21.56
Average	18.49	6.80	19.68	7.38	19.18	7.19

Statistical analysis showed significant differences among the lots only in feeding trial I. The consumption of lot II for every 100 kilo-

grams liveweight was significantly higher than those of lots I and III. The S.M.D. for the lots in this trial was 0.47 kilograms. In feeding trial II, however, there were no significant differences in the consumption of the lots.

Miscellaneous observations. The color of the silage in lot I was amber; in lots II and III, slightly greenish which gave the silages an olive color. The intensity of their color deepened in direct proportion to the amount of madre de cacao leaves in the silage.

The silages had similar odor but lot III had the most pleasant smell.

The feces of the cows were characteristic of those normally excreted by cows fed with other silages.

The initial average weight of the animals in feeding trial I was 294.5 kilograms, and the final average weight was 252.8 kilograms. In feeding trial II, the initial average weight of the animals was 256.5 kilograms, and the final average weight was 275.2 kilograms.

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THE EFFECT OF TIME OF LODGING UPON THE YIELD AND OTHER AGRONOMIC CHARACTERISTICS OF RICE [1]

D. L. Umali, E. S. Castillo and P. S. Castillo

The greatest reduction in grain yield of Mangasa, Thailand and Milfor 6(2) occurred when the plants were lodged two weeks before heading; the least reduction when the plants were lodged two weeks after heading. The decrease in yield due to natural lodging was less in Milfor 6(2) than in the other varieties with poor standability. Earlier maturity was noted when the plants were lodged later. The height of plants as well as percentage of milling recovery increased as artificial lodging was delayed. Grain density was hardly affected by the different treatments. Kernel color and texture were adversely affected by early lodging.

Previous studies have shown that lodging makes harvesting difficult, reduces yield, and sometimes causes deterioration of kernel quality. It has been observed that the adverse effect of lodging depends on the time it occurs. Percival (1930), Welston and Morris (1931), Donald (1935), and Harlan and Martini (1936) reported that when lodging occurs late in the growing period, the effect on the plants is not as adverse as when it occurs in the early growing period, especially before and during heading time. Results of studies by Pillai (1948) and Ramiah (1949) in India showed that yields were reduced to about 60-63 per cent by early lodging as compared with a reduction of 50 per cent for late lodging. To obtain further information on the effects of lodging on rice yield, a study on controlled lodging was undertaken in the lowland rice field of the College of Agriculture in the dry season planting of 1954.

MATERIALS AND METHODS

Three rice varieties were used in the experiment: Milfor 6 (2), resistant to lodging; Thailand, medium-lodging, and Mangasa, susceptible to lodging. Seedlings of these varieties grown in a "Dapog" seedbed were transplanted nine days after sowing. Three to five seedlings were planted to a hill, 20 centimeters apart in a row and 30 centimeters between rows. The plots consisted of four rows, five meters long and spaced 0.5 meter apart. Two weeks after trans-

[1] Central Experiment Station Contribution No. 1906.

planting, the plants were fertilized with ammonium sulfate (20-0-0) at the rate of 150 kilograms per hectare. The missing hills were replanted a week after transplanting. Handweeding was done when necessary.

A split-plot randomized design with three replications was used. The varieties were the main plots and six treatments were the subplots. Treatments consisted of artificial lodging at various stages of development induced by pressure on the plants with bamboo slats pinned to the ground. Some plants were supported by stakes to prevent lodging and other plants were allowed to lodge naturally.

The plants were observed during the tillering, booting, flowering, and maturing stages for pest and disease damage. The height of the plants and the number of bearing culms were recorded a week before harvest.

The harvested grains from the two inner rows were dried, threshed, and weighed before and after they were winnowed to find the weight of filled and unfilled grains. One hundred gram samples from the harvest of each treatment were milled to determine the milling recovery. Based on 14 per cent moisture the yield in cavans per hectare was calculated for each treatment. To determine grain density on a 14 per cent moisture basis, ten grains from each treatment were weighed with an analytical balance.

RESULTS AND DISCUSSION

Yield

There was a consistent increase in yield as the time of lodging was delayed (table 1). The propped or non-lodged plants gave the highest yield. The differences between the means of the propped plots and those that were lodged two weeks after heading were not statistically significant, except in the Thailand variety. But from the practical standpoint, such differences were of importance since the non-lodged plants of the three varieties consistently yielded more than those that lodged two weeks after heading.

The yield of the propped plants was numerically greater than of those allowed to lodge naturally. The highly significant interaction between variety and treatment showed that the yield of the three varieties were not similarly affected by the different treatments.

TABLE 1.—*Effect of time of lodging on yield* [a]

VARIETY	TREATMENT *	REPLICATION I	REPLICATION II	REPLICATION III	TOTAL	MEAN
Mangasa	1	13.5	19.1	20.5	53.1	17.7
	2	9.3	25.5	20.6	55.4	18.4
	3	16.1	27.2	37.7	81.0	27.0
	4	50.3	54.7	72.9	177.9	59.3
	5	53.2	61.7	115.3	230.2	76.7
	6	53.8	41.6	61.7	157.1	52.3
Total		196.2	229.8	328.7	754.7	41.9
Thailand	1	30.6	30.8	37.0	98.4	32.8
	2	58.5	46.9	50.9	156.3	52.1
	3	55.6	46.4	61.3	163.3	54.4
	4	61.6	63.6	58.4	183.6	61.2
	5	61.8	99.4	102.4	263.6	87.8
	6	88.7	75.9	98.2	262.8	87.6
Total		356.8	363.0	408.2	1128.0	62.7
Milfor 6 (2)	1	16.0	29.6	22.4	68.0	22.6
	2	87.5	56.1	55.8	199.4	66.4
	3	88.1	82.2	100.4	270.7	90.2
	4	98.8	110.4	119.4	328.6	109.5
	5	106.4	121.3	123.4	351.1	117.0
	6	92.4	125.1	115.3	332.8	110.9
Total		489.2	524.7	536.7	1550.6	86.1
Replication Total		1042.2	1117.5	1273.6	3433.3	

[a] Cavans/ha; one cavan is 44 kilograms at 14% moisture content.

* 1. Lodged artificially two weeks before heading.
2. Lodged artificially at heading time.
3. Lodged artificially one week after heading.
4. Lodged artificially two weeks after heading.
5. Propped with stakes to prevent lodging (check).
6. Allowed to lodge naturally (unpropped).

Analysis of Variance

SV	DF	SS	MS	COMPUTED F
Variety (V)	2	17,618.51	8,809.26	70.55 [b]
Replication (R)	2	1,547.84	773.92	6.20
V × R	4	499.42	124.86	
Treatment (T)	5	30,496.48	6,099.30	40.80 [b]
T × V	10	5,088.87	508.89	3.40 [b]
Pooled Error	30	4,484.91	149.50	
Total	53	59,736.03		

[b] Highly significant.

SMD at 5% (V) = 10.35
SMD at 1% (V) = 17.13
SMD at 5% (T) = 11.75
SMD at 1% (T) = 15.84
SMD at 5% (T × V) = 20.36
SMD at 1% (T × V) = 27.44

The maximum reduction in yield of the three varieties ranged from 62.6 (Thailand) to 80.9 per cent (Milfor 6 [2]) (table 2). The decrease in yield due to natural lodging depends on the standability of the variety. Natural lodging for Milfor 6 (2) was less than one per cent at maturity; Thailand, 8.8 per cent; and Mangasa, 31.8 per cent. Mangasa had the highest decrease in yield while Milfor 6 (2) had the least reduction. The percentage of chaff was much higher for the lodged plots. Hence it appears that the low yield of the lodged plants could be explained by failure of the grains to develop properly. Lodging also delayed the maturity of the plants.

TABLE 2.—*Percentage reduction in yield, percentage of chaff, milling recovery and kernel color and texture*

VARIETY	TREATMENT *	% YIELD REDUCTION [a]	PERCENTAGE OF CHAFF	MILLING RECOVERY	KERNEL COLOR AND TEXTURE
Mangasa	1	76.9	48.6	49.6	dark brown and chalky
	2	76.0	46.7	52.66	dark brown and chalky
	3	64.8	31.4	54.00	brown and medium chalky
	4	22.7	18.6	58.50	white and chalky
	5		19.1	63.33	white and chalky
	6	31.8	20.2	63.33	white and chalky
Thailand	1	62.6	31.2	53.83	brown and chalky
	2	40.7	34.4	57.50	white and chalky
	3	36.0	34.9	58.33	white and medium chalky
	4	30.3	28.8	59.60	white and medium chalky
	5		22.3	61.00	white and medium chalky
	6	8.8	25.2	59.1	white and medium chalky
Milfor 6 (2)	1	80.9	38.1	66.16	brownish and medium chalky
	2	43.2	45.1	67.50	brownish and medium chalky
	3	22.9	31.8	66.16	light brown and flinty
	4	9.0	23.4	63.66	white and flinty
	5		20.1	63.86	white and flinty
	6	0.8	20.6	64.33	white and flinty

[a] As compared to the check (propped plants).
* See table 1.

Agronomic Characteristics

Height of plants. Early lodging reduced the height of plants of the three varieties. (table 3). The tallest plants were those artificially lodged two weeks after heading. It is possible that at this period the plants had attained their maximum height, hence, lodging did not have any stunting effect. The highly significant interaction, variety x treatment, indicated that the height of plants of the three varieties were not similarly affected by the different treatments.

TABLE 3.—*Effect of time of lodging on height of plants in cm.*

VARIETY	TREATMENT *	REPLICATION			TOTAL	MEAN
		I	II	III		
Mangasa	1	85.9	84.4	85.6	255.9	85.3
	2	89.3	97.1	91.1	277.5	92.5
	3	111.6	92.5	106.0	310.1	103.0
	4	136.2	133.3	132.6	402.1	134.0
	5	128.0	122.9	128.4	379.3	126.4
	6	138.9	135.4	126.9	401.2	133.7
Total		689.9	665.6	670.6	2026.1	112.6
Thailand	1	101.1	101.6	101.9	304.6	101.5
	3	129.9	131.5	135.3	396.7	132.2
	3	132.4	120.5	119.1	372.0	124.0
	4	142.7	133.4	128.1	404.2	134.7
	5	147.1	131.2	125.6	403.9	134.6
	6	148.1	136.5	133.1	417.7	139.2
Total		801.3	754.7	743.1	2299.1	127.7
Milfor 6 (2)	1	106.5	114.3	92.5	313.3	104.4
	2	114.5	107.2	115.6	337.3	112.4
	3	120.0	119.5	116.4	355.9	118.6
	4	137.5	133.9	134.0	405.4	135.1
	5	136.7	135.4	136.3	408.4	136.1
	6	140.3	131.8	133.6	405.7	135.2
Total		755.5	742.1	728.4	2226.0	123.6
Replication Total		2246.7	2162.4	2142.1	6551.2	

* See table 1.

Analysis of Variance

SV	DF	SS	MS	COMPUTED F
Variety (V)	2	2,219.12	1,109.56	49.01 [a]
Replication (R)	2	341.84	170.92	7.54 [b]
V × R	4	90.55	22.64	
Treatment (T)	5	10,982.04	2,196.41	78.05 [a]
T × V	10	1,688.56	186.86	6.00 [a]
Pooled Error	30	844.33	28.14	
Total	53	16,166.44		

[a] Highly significant.
[b] Significant.

SMD at 5% (V) = 4.42
SMD at 1% (V) = 7.31
SMD at 5% (T) = 2.50
SMD at 1% (T) = 6.88
SMD at 5% (T × V) = 8.83
SMD at 1% (T × V) = 11.91

Number of bearing culms and size of panicles. The mean number of tillers of the three varieties became less while the mean number of bearing culms increased as lodging was delayed (table 4). Early lodging which caused the death of some of the primary tillers encouraged tillering.

TABLE 4.—*Mean number of tillers and of bearing culms, size of panicles, mean number of days to heading and maturity*

VARIETY	TREATMENT *	MEAN NO. OF TILLERS	MEAN NO. OF BEARING CULMS	SIZE OF PANICLES	MEAN NO. OF DAYS TO HEADING	MATURITY
				(*cm.*)		(*days*)
Mangasa	1	22	8.8	19.2	88	114
	2	19	9.7	19.3	86	108
	3	18	11.2	20.4	86	105
	4	17	11.4	22.3	84	103
	5	16	13.2	22.8	85	104
	6	16	15.7	23.1	85	101
Thailand	1	20	8.4	19.4	90	108
	2	18	9.1	21.3	90	106
	3	18	10.8	21.7	89	106
	4	18	12.3	24.4	89	106
	5	16	13.0	26.3	88	104
	6	16	13.6	25.5	88	105
Milfor 6 (2)	1	20	14.8	28.0	93	121
	2	20	16.7	28.8	94	116
	3	18	18.1	29.7	91	118
	4	19	16.7	29.5	90	116
	5	17	16.6	29.9	91	118
	6	17	16.2	30.1	90	118

* See table 1.

There was a progressive increase in size of panicles with later lodgings. The panicles produced by unlodged plants were longest and those produced by plants that lodged two weeks before heading were shortest.

Maturity period. Thailand and Mangasa matured earlier but not uniformly. This is true especially of the treatments that lodged earlier. Mangasa matured in 100 to 114 days, with an average of 107 days.

Susceptibility to pests and diseases. Plants that were artificially lodged were damaged by rats at the start of the booting stage. This damage was easily controlled by irrigating the paddies to their full capacity and by using poison baits and mouse traps. The three

varieties were attacked by rice bugs (*Leptocorisa acuta* Thunberg) during the flowering and milk stages. Mangasa was also attacked by the red rice weavers (*Lonchura ferruginosa jagori* Martens) at maturity but damage was slight because the field was closely guarded by a watcher. Milfor 6 (2) was least attacked by insect pests because it flowered and matured at the same time as the majority of the rice crops in the locality.

Milling recovery and kernel texture. Results indicate that reduction of milling recovery due to early lodging depends on the kernel texture of the variety (table 2). For Thailand and Mangasa, both with chalky kernels, early lodging reduced considerably the milling recovery. However, with Milfor 6 (2) which has flinty kernels, there was no appreciable reduction of milling recovery.

The poor development of the grains due to early lodging affected the color of the kernels of the three varieties (table 2). The chalky varieties produced darker kernels when the plants were lodged before heading time.

RECOMMENDATION

Inasmuch as the adverse effects of lodging depend largely on the stage of growth and development of the rice plant when lodging takes place, standability readings in experimental trials should be recorded at various stages of development. It is recommended that readings on lodging be taken three times—at heading time, two weeks after heading, and at maturity—to obtain a more precise measure of resistance to lodging. At each reading, the total percentage of lodged plants should be recorded.

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TESTS OF FIVE INSECTICIDAL SPRAYS IN THE CONTROL OF INSECTS AFFECTING TOBACCO [1]

ALEJANDRO I. YADAO

Of the five insecticides tested only Calcium arsenate caused drying of the leaves.

DDT gave the best protection to the leaves against insects, followed by Endrin, Calcium arsenate, Parathion and Lindane.

Laboratory tests showed that Parathion was the fastest in killing the adult of *Phaneroptera furcifera*, followed by Lindane, Endrin, Calcium arsenate and DDT. Against *Prodenia litura*, Parathion and Endrin gave a complete kill in 24 hours.

There were no significant differences in yield among the treatments.

The low yield and poor quality of tobacco in the Philippines are largely attributed by farmers to damage by a number of insect pests.

Uichanco and Sacay (1949) reported that the tobacco stem borer, *Gnorimoschema heliopa* Low, and the cutworm, *Prodenia litura* Fabr. cause serious damage to tobacco stems and leaves. Paguirigan and Tugade (1940) reported that the false budworm, cutworm, and hornworm are universally admitted to be the most destructive insect pests of tobacco. In 1951, Metcalf and Flint found that *Heliothis armigera* Hubn., a green caterpillar which feeds on the bud, caused great damage during summer. Otanes (1953) reported that *Phaneroptera furcifera* in great numbers riddled tobacco leaves with holes.

Several studies have been made on the control of tobacco insect pests by the use of insecticidal sprays. Jones (1913) found that Lead arsenate controlled cutworms. Michener (1952) controlled cutworms with Endrin, Dieldrin, Aldrin and Isodrin in bran-water baits. Wene and Blanchard (1953), Hayslip *et al.* (1953), Brazzle *et al.* (1953), and Eden (1953) confirmed that DDT is effective against *Heliothis armigera.*

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[1] Central Experiment Station Contribution No. 1907. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, March, 1956. Prepared in the Department of Entomology under the direction of Dr. John G. Matthysse, former visiting Cornell professor.

While some insecticides are now being used in the Philippines against tobacco pests their efficacy has not been thoroughly ascertained. The present work was therefore conducted to determine (a) the effectiveness of DDT, Parathion, Endrin, Lindane and Calcium arsenate in controlling insects affecting tobacco, (b) the herbicidal effects of these insecticides and (c) the effects of the treatments on the yield and quality of tobacco. The study was conducted at the Central Experiment Station and in the laboratory of the Department of Entomology from January, 1955, to January, 1956.

MATERIALS AND METHODS

Five insecticidal sprays were used in the field tests. The organic insecticides used were: (1) Parathion (Folidol E 605, an emulsifiable concentrate containing 46.7 per cent Parathion, (2) an emulsifiable concentrate containing 19.5 per cent Endrin, (3) Isotox 200, containing 20 per cent Lindane emulsifiable concentrate and (4) Gesarol E-25, containing 25 per cent DDT emulsifiable concentrate.[2] The inorganic insecticide used was Calcium arsenate,[3] a wettable powder containing 69 per cent active ingredient.

The insecticides were sprayed with a compressed-air hand sprayer with two-gallon capacity at the following rates to a gallon of water: 4.7 milliliters Isotox, 19 milliliters Gesarol, and 13.7 grams Calcium arsenate.

Harrison Special variety seedlings of Virginia tobacco were planted when they were six weeks old in a lot at the Central Experiment Station at distances of 80 centimeters between rows and 70 centimeters between plants. The distance between treatments was far enough to prevent contamination.

The experimental lot was divided into three randomized blocks, each block consisting of ten treated plots and a check plot. The ten treatments included one of each insecticide sprayed at weekly intervals, and one of each insecticide sprayed every two weeks. Plots that were sprayed weekly received sixteen spray applications, and the plots that were sprayed every two weeks received eight spray applications.

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[2] Folidol E 605 was obtained from Farbenfarboiken Bayer Aktiengesseleschaft, the emulsifiable concentrate containing 19.5 per cent Endrin from Shell Co., Isotox 200 from California Spray Chemical Co., and Gesarol E-25 from Geigy Agricultural Chemicals.

[3] A duPont product.

Spraying was started 15 days after transplanting and was continued for sixteen weeks thereafter.

Observations were made on the herbicidal effects of the different insecticides.

Harvesting was done five times at two-week intervals. The first harvest was made 68 days after the plants were transplanted. When the leaves were thoroughly dried, the total yield in kilograms was taken.

Other observations made were: (1) insect population after every spraying, (2) total number of plants in a plot, (3) total number of undamaged, slightly damaged, and seriously damaged leaves, and (4) diseases that infested the plants.

In the laboratory tests three randomized blocks were used, each block consisting of five treatments and a check plot. A plot consisted of one cage. *Phaneroptera furcifera* was the first insect tested. Five young undamaged tobacco leaves were sprayed separately with the different insecticides by the use of a household fly-spray hand sprayer. Except for Parathion, the concentrations of the various spray materials differed from those used in the field test. Gesarol E-25 was used at 41.7 milliliters per gallon, Folidol at 4.7, Endrin and Isotox at 18.42 milliliters and Calcium arsenate at 29 grams per gallon. When the spray had dried, the petiole of each leaf was immersed in a vial of water. Ten adult *Phaneroptera furcifera* collected in the field were introduced into each cage. The extent of feeding and the number of living, moribund, and dead insects were noted at 3, 12, 24, 36, 48, and 72 hours after treatments, at which time all insects in the treated cages were dead.

The second insect tested in the laboratory was *Prodenia litura*. The larvae used were of similar size. The procedure followed in the first insect test was duplicated.

RESULTS AND DISCUSSION

Field tests

Insects that infested the plants. Insects found attacking the plants in the field were: (1) *Prodenia litura* Fabr., (2) *Heliothis armigera* Hubn., (3) *Phaneroptera furcifera* Stal., (4) *Plusia chalcytes* Fabr., (5) *Engytatus tenuis* Reuter and (6) *Oecanthus indicus* de Sausure.[4]

[4] Identified by Dr. S. M. Cendaña of the Department of Entomology.

Young budworms, *Heliothis armigera,* fed on the leaves where they hatched and as they grew larger, they ate the entire bud. The larvae which were killed while young, bored small holes which became prominent in the expanded leaves.

The cutworm, *Prodenia litura,* was observed feeding voraciously on young plants. The young larvae did not cause much damage, but as they grew older, they consumed almost entire leaves.

Phaneroptera furcifera was noted three weeks after transplanting. Both nymphs and adults of this species fed on both young and mature leaves.

Plusia chalcytes was found, but only too few to cause much damage. It attacked mostly the semi-mature leaves. The larvae fed on the leaf blade. They were found mostly on the under side of the leaves.

The hemipteron, *Engytatus tenuis* which was abundant during the experiment, sucked the sap of the young tissues of the plant.

Oecanthus indicus, found in some plots, fed on the tobacco bud.

Herbicidal effects of the insecticidal sprays. Plants sprayed with Calcium arsenate showed signs of injury. The injury which appeared as drying of the leaf blade along the margins was severe in plants that were sprayed at weekly intervals. Plants sprayed with the other insecticides did not show apparent sign of injury. The control plants were normal in appearance.

Insect damage to the leaves. The percentage of undamaged leaves is shown in table 1. Except for Lindane applied 8 times, all the treatments were significantly better than the control at 1 per cent level. DDT applied 16 times was significantly better at 1 per cent level than Parathion and Lindane applied at the same interval. There was no difference among DDT, Endrin, and Calcium arsenate at 16-time applications. Results from DDT applied 16 times and DDT applied 8 times did not differ significantly.

Insect population. Caterpillar population in the treated plots at 1 per cent level decreased significantly from that of the control (table 2a). There were no significant differences among DDT,Parathion, Endrin, and Calcium arsenate applied 16 times. Caterpillar population in the Lindane-treated plots was 22 times greater than in the DDT-treated plots. There were no significant differences between the results of the 16-time and the 8-time applications of any one insecticide.

TABLE 1.—*Percentage of undamaged leaves based on total number of leaves from five harvesting*

INSECTICIDE	TREATMENT	REPLICATION I	II	III	TOTAL	MEAN	ANGLE TRANSFORMED MEAN
DDT	16×	88.14	97.42	88.14	273.75	91.25	73.48
	8×	72.46	88.16	89.67	250.29	83.43	66.52
Parathion	16×	71.88	76.87	74.18	222.93	74.31	59.57
	8×	50.39	48.62	49.60	148.61	49.53	44.67
Endrin	16×	89.59	78.23	92.59	260.39	86.79	69.19
	8×	65.80	80.82	73.96	220.58	73.52	58.82
Lindane	16×	42.40	63.03	46.31	151.74	50.58	45.32
	8×	32.79	20.83	45.77	99.39	33.13	34.88
Ca arsenate	16×	75.32	83.56	85.16	240.04	81.34	64.54
	8×	60.07	69.11	64.91	194.09	64.69	53.57
Check		24.26	8.85	21.93	55.04	18.32	24.98
Total		673.15	715.50	732.20	2120.85		

Analysis of variance (Angles)

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	10	6899.94	689.99	23.81 [a]
Replications (R)	2	86.56	43.28	1.41
T × R	20	579.69	28.98	
Total	32	7566.19		

[a] Highly significant.

SMD at 5% (T) = 9.91 (Angles)
SMD at 1% (T) = 12.85

TABLE 2a.—*Total caterpillars found in sixteen counts*

INSECTICIDE	TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
DDT	16×	0	0	0	0	0.0
	8×	0	1	2	3	1.0
Parathion	16×	3	10	9	22	7.3
	8×	12	15	7	34	11.3
Endrin	16×	1	4	0	5	1.7
	8×	2	4	3	9	3.0
Lindane	16×	26	20	19	65	21.7
	8×	32	51	20	103	34.3
Ca arsenate	16×	14	0	0	14	4.7
	8×	23	14	8	45	15.0
Check		67	71	35	173	58.0
Total		180	190	103	473	

Analysis of variance

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	10	9466.66	946.67	15.74 [a]
Replication (R)	2	412.06	206.03	3.43
T × R	20	1202.61	60.13	
Total	32	11081.33		

[a] Highly significant.

SMD at 5% (T) = 13.20
SMD at 1% (T) = 17.98

Population of *Phaneroptera furcifera* is shown in table 2b. There were instances when there were more *P. furcifera* in the Endrin-treated plots than in the control. In most cases there were less *P. furcifera* in the treated plots, but the differences were not significant.

TABLE 2b.—*Total Phaneroptera furcifera found in sixteen counts*

INSECTICIDE	TREATMENT	REPLICATION			TOTAL	MEAN
		I	II	III		
DDT	16×	3	0	1	4	1.3
	8×	6	0	0	6	2.0
Parathion	16×	5	10	0	15	5.0
	8×	4	6	0	10	3.3
Endrin	16×	4	18	4	26	8.3
	8×	14	0	7	21	7.0
Lindane	16×	2	1	4	7	2.3
	8×	1	7	2	10	3.3
Ca arsenate	16×	0	1	0	1	0.3
	8×	0	4	1	5	1.7
Check		6	6	4	16	5.3
Total		45	53	23	121	

Analysis of variance

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	10	198.00	19.80	1.24 [a]
Replication (R)	2	43.88	21.94	3.49
T × R	20	319.45	15.97	
Total	32	561.33		

[a] Insignificant.

In some instances, *Engytatus tenuis* appeared more in the lots treated with Lindane 8X and Calcium arsenate 8X than in the control plots (table 2c). The only treatments that reduced population significantly were DDT 16X and 8X. No significant differences between the 16-time and the 8-time applications were found.

TABLE 2c.—*Total Engytatus tenuis found in sixteen counts*

INSECTICIDE	TREATMENT	REPLICATION			TOTAL	MEAN
		I	II	III		
DDT	16×	12	5	8	25	8.3
	8×	18	12	11	41	13.7
Parathion	16×	12	39	9	60	20.0
	8×	25	9	13	47	15.7
Endrin	16×	14	31	0	45	15.0
	8×	28	24	23	75	25.0
Lindane	16×	26	15	20	61	20.3
	8×	29	71	50	150	50.0
Ca arsenate	16×	45	26	22	93	31.0
	8×	26	98	33	157	52.3
Check		33	44	39	116	36.7
Total		268	374	228	870	

Analysis of variance

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	10	6643.36	664.34	2.86 [a]
Replication (R)	2	1034.91	517.46	2.22
T × R	20	4657.37	232.87	
Total	32	12335.64		

[a] Highly significant.

SMD at 5% (T) = 15.95
SMD at 1% (T) = 22.69

Yield. There were no significant differences in yield as determined by weight of leaves produced due to the uneven attack of root rot disease (table 3).

Laboratory tests

On the adult of Phaneroptera furcifera. Twelve hours after treatment all *P. furcifera* were alive in the Calcium arsenate and check cages (table 4a). Except for Calcium arsenate, all insecticides gave a very significant kill over that of the control. At the

5 per cent level, Lindane was significantly more effective than Endrin and DDT. Parathion was significantly more effective at 1 per cent level than DDT and at 5 per cent level than Endrin and Lindane.

TABLE 3.—*Weight of tobacco leaves in kilograms taken from five harvesting*

INSECTICIDE	TREATMENT	REPLICATION			TOTAL	MEAN
		I	II	III		
DDT	16×	.86	.33	.46	1.65	.55
	8×	.71	.14	.20	1.05	.35
Parathion	16×	.80	1.04	.47	2.31	.77
	8×	.29	.42	.14	.85	.28
Endrin	16×	.53	.82	.17	1.52	.51
	8×	.95	.74	.81	2.50	.83
Lindane	16×	.48	.16	.25	.89	.30
	8×	.28	1.08	.35	1.71	.57
Ca arsenate	16×	.74	.23	.30	1.27	.42
	8×	.51	.57	.38	1.46	.49
Check		.34	.69	.19	1.22	.40
Total		6.49	6.22	3.72	16.43	

Analysis of variance

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	10	.95	.10	1.67 [a]
Replication (R)	2	.42	.21	3.50
T × R	20	1.12	.06	

[a] Insignificant.

TABLE 4.—*Percentage of dead Phaneroptera furcifera 12 hours after treatment*

TREATMENT	REPLICATION			TOTAL	MEAN	ANGLE TRANSFORMED MEAN
	I	II	III			
DDT	0	10	30	40	13.3	17.22
Parathion	100	100	100	300	100.0	90.00
Endrin	30	20	50	100	33.3	34.92
Lindane	90	70	80	240	80.0	68.16
Total	220	200	260	680		

Analysis of variance (Angles)

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	3	9616.26	3205.42	20.25 [a]
Replication (R)	2	201.61	100.80	0.64
T × R	6	937.27	156.21	
Total	11	10755.14		

[a] Highly significant.

SMD at 5% (T) = 32.46
SMD at 1% (T) = 59.58

On the larvae of *Prodenia litura.* Twelve hours after treatment all *P. Litura* were alive in the Calcium arsenate and check cages (table 5). There was no significant difference noted in the effects of Lindane, DDT and Endrin. Parathion was significantly more effective at 5 per cent level than all other treatments.

Prodenia litura was killed in 24 hours by Parathion and Endrin, in 36 hours by DDT and Lindane, and in 96 hours by Calcium arsenate.

TABLE 5.—*Percentage of dead Prodenia litura 12 hours after treatment*

INSECTICIDE	REPLICATION			TOTAL	MEAN	MEAN ANGLE
	I	II	III			
DDT	40	20	20	80	26.7	30.78
Parathion	80	70	90	240	80.0	63.93
Endrin	30	50	50	130	43.3	41.07
Lindane	20	40	40	100	33.3	35.00
Total	170	180	200	550		

Analysis of variance (Angles)

SV	DF	SS	MS	COMPUTED F VALUE
Treatment (T)	3	2046.80	682.26	35.44 [a]
Replication (R)	2	300.59	150.29	0.78
T × R	6	115.52	19.25	
Total	11	2462.91		

[a] Highly significant.

SMD at 5% (T) = 11.36
SMD at 1% (T) = 20.87

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The yoking of science to technology gave man a vantage ground for innovation, for significant action, and for the development of the potentialities of human nature.

—*Samuel Levin*

ALKALINE DEGRADATION OF COCONUT MILK [1]

CLEDUALDO B. PEREZ, JR. and APOLINARIO R. CARAÑGAL, JR.

WITH FIVE TEXT FIGURES

The acids that were formed and tentatively identified by their displacement volumes on the silica gel column were acetic, formic, lactic, oxalic, glycolic, and malic acids. Of these acids the most plentiful was lactic acid. The kinds of acids formed were not dependent on the reaction conditions.

The amount of lactic acid formed was dependent upon the alkali concentration and the time and temperature of the reaction. The largest amount of lactic acid formed, 12.39 mg. per ml. of hydrolyzed coconut milk (watery endosperm), was obtained with 1.5 N KOH after 72 hours of reaction under room temperature (24-30°C). Such low yield indicates that coconut milk is not a promising source of lactic acid by this method.

Coconut milk (watery endosperm), especially of the young nuts, is used principally as beverage in the Philippines. To a limited extent, vinegar is prepared from it by spontaneous fermentation. Because of the abundant supply of other local raw materials, the milk has not been used as a source of sugar and alcohol. Child and Nathanael (1947) found that it was not a good source of sugar or a promising source of alcohol. However, they discussed the use of the milk in cattle feeding, as rubber coagulant, and as fertilizer. Blakeslee (1949) found that coconut milk stimulated the growth of normal embryos of *Datura stramonium.* Tissues of *Parthenocissus tricuspidata,* Jerusalem artichoke tubers, plant virus tumor, crown galls of grape vines, tobacco, artichoke, salsify, and coconut embryos were cultured *in vitro* using coconut milk. These studies indicated the presence of some growth substances.

Studies have also been undertaken on the therapeutic value of the milk by J. Bejarano (1933). He claimed that coconut milk when substituted for cow's milk could be used in the treatment of gastric disturbances of infants.

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[1] Central Experiment Station Contribution No. 1809. Thesis presented by the senior author for graduation with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, March, 1956. Prepared in the Department of Agricultural Chemistry under the direction of the junior author.

The nutritive value of coconut toddy has been discussed and reviewed by Nicholls and Drummond (1945), and Leong (1950).

Because of the tremendous amounts of coconut milk that go to waste it is important to find other means of disposal. The presence of sugars suggests that acids may be formed either by fermentation or alkaline degradation. Nef, Evans, *et al* (cited by Montgomery, 1951) studied the alkaline degradation of sugars leading to the production of lactic, acetic, formic, oxalic, and glycolic acids. Since the total solids are principally glucose, sucrose, and levulose, acids may also be formed from coconut milk.

This study conducted from September, 1955 to March, 1956, deals with the production of acids by the action of alkali on coconut milk. The effect of the concentration of the alkali, and the time and temperatre of the reaction on the formation of the acids were also investigated.

MATERIALS AND METHODS

Coconut milk collected from 20 mature nuts was concentrated by boiling down to one-fifth of its original volume and hydrolyzed overnight with the required concentration of H_2SO_4. The sulfate was precipitated with calcium carbonate and separated by suction filtration. The filtrate was neutralized with dilute sodium hydroxide solution and then used in subsequent reactions.

Two batches of coconut milk were used. The first, which had been concentrated and hydrolyzed, was used for reactions at room temperature; the second which was hydrolyzed without previous concentration was used for reactions at 100°C. The amount of reducing sugars in these hydrolyzed solutions was determined according to the official tentative methods of the A.O.A.C. (1950).

Reaction conditions. Distilled water and 5.0 N KOH were added to the neutralized filtrate to give the required alkali concentration in the reaction mixture. One hundred milliliters of each reaction mixture was prepared with KOH concentrations of 0.10, 0.50, 1.00, 1.50, and 2.00 N. Five ml. aliquots of each of the reaction mixtures were pipetted into test tubes with corks and allowed to stand under the desired reaction temperature. The reaction mixtures under room temperature (24-30°C) were maintained at 24, 48, and 72 hours; and at boiling temperature (100°C), 0.5, 1.0 and 2.0 hours. In the latter experiments, the test tubes were placed in a boiling water bath under atmospheric conditions.

After obtaining the desired reaction, 1.0 N H_2SO_4 was added to overneutralize the base and thus stop the reaction. Each acidified reaction mixture was then evaporated to dryness. Four trials were made for each reaction condition.

Separation and determination of the organic acids. The evaporated mixtures served as organic acid fractions. Their acid contents were separated on a silica gel column and determined by titration according to the procedure of Bulen, Varner, and Burrell (1952). No actual chemical identification of the acids was made but these were tentatively identified by their displacement volumes. The acids originally present in the hydrolyzed coconut milk were also determined.

All results were expressed in milliequivalents of acids. Together with the amount of reducing sugars as glucose, the amount of lactic acid formed was also expressed in milliequivalents per millimole of glucose.

RESULTS AND DISCUSSION

Acids formed. The hydrolyzed coconut milk was found to contain some malic acid and traces of oxalic and glycolic acids.

The chromatogram of the reaction mixture shows four different peaks (fig. 1). These peaks correspond to lactic, oxalic and/or glycolic, and malic acids. In preliminary experiments, the volatile acids (acetic and formic) were also obtained. Determination of these acids had to be discontinued because evaporation of the reaction mixture would necessitate the addition of alkali which may cause further reaction. Although the hydrolyzed coconut milk exhibited similar peaks, the larger amounts of the acids of the reaction mixture compared with those of the corresponding acids of an equal amount of coconut milk suggest that the former were formed by alkaline degradation.

All these acids, except malic acid, were reported by Montgomery (1951) as having been formed during the degradation of sucrose and molasses. The nature of the acids produced was not affected by the alkali concentration, and the time and temperature of the reaction. However, the amounts of acids formed varied depending on the reaction conditions. Of the acids formed, lactic acid was largest in amount; hence, subsequent experiments revolved around it.

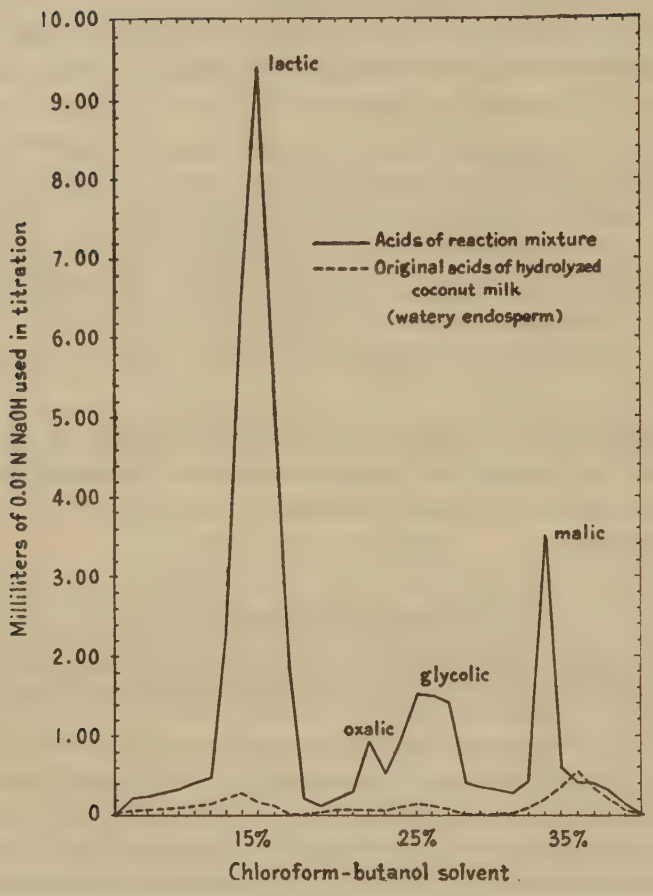

Fig. 1.—Chromatographic separation of the acids of coconut milk and the products of the alkaline degradation of coconut milk in a silica gel column.

Effect of alkali concentration. The titration values and the calculated milliequivalents of lactic acid per millimole of glucose are presented in tables 1a, 1b, 2a, and 2b. Statistical analyses of these data reveal highly significant effect of alkali concentration on the formation of lactic acid.

At room temperature, production of lactic acid increased with increase in alkali concentration up to a certain normality, and then decreased rapidly with further increase in concentration (fig. 2a). The concentration means show that the amounts of lactic acid formed at 0.10 N and 0.50 N did not give any significant difference (table

TABLE 1a.—*Effect of KOH concentration and length of time of reaction on the formation of lactic acid at room temperature (24-30° C.)*

TIME OF REACTION	TRIAL	KOH CONCENTRATION (N)				
		0.10	0.50	1.0	1.5	2.0
hours		*milliequivalents* × 10^2				
24	1	1.54	7.77	34.34	22.23	32.78
	B	0.95	8.30	35.06	34.78	30.67
	3	0.72	5.19	35.91	42.00	30.90
	4	1.04	6.34	38.71	33.40	26.45
	Ave.	1.06	6.90	36.01	33.07	30.20
48	1	1.08	6.24	49.38	68.03	32.38
	2	1.09	4.85	41.37	68.48	36.57
	3	0.94	7.68	42.54	64.91	35.29
	4	1.24	8.45	46.65	73.41	31.43
	Ave.	1.09	6.81	44.98	68.71	33.92
72	1	0.69	6.43	48.08	72.53	48.69
	2	0.91	13.37	53.60	72.41	32.12
	3	0.72	4.58	57.26	78.50	34.51
	4	0.34	5.36	42.53	62.78	38.48
	Ave.	0.65	8.43	50.37	71.55	38.45

TABLE 2a.—*Effect of KOH concentration and length of time of reaction on the formation of lactic acid at boiling temperature (100° C.)*

TIME OF REACTION	TRIAL	KOH CONCENTRATION (N)				
		0.10	0.50	1.0	1.5	2.0
hours		*milliequivalents* × 10^2				
0.5	1	1.24	18.18	27.87	27.89	27.27
	2	1.19	14.87	30.80	29.69	26.78
	3	2.26	13.27	27.16	30.27	32.23
	4	1.32	15.48	31.46	28.64	31.42
	Ave.	1.50	15.45	29.32	29.12	29.42
1.0	1	1.61	22.49	25.68	22.12	27.55
	2	1.59	17.58	30.84	26.28	28.60
	3	1.96	15.74	30.37	29.04	31.16
	4	1.72	16.58	28.46	27.65	28.30
	Ave.	1.72	18.10	28.84	26.27	28.90
2.0	1	0.73	15.21	42.66	44.63	30.00
	2	2.75	21.83	35.13	37.54	31.73
	3	2.52	22.57	35.87	44.72	36.89
	4	1.67	17.56	37.42	40.56	29.52
	Ave.	1.92	19.29	37.77	41.86	32.04

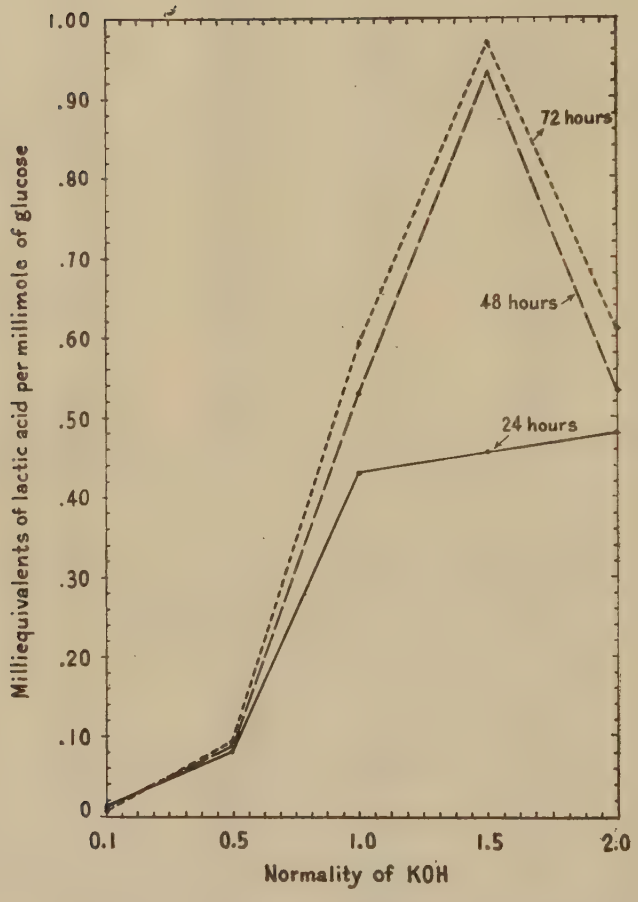

Fig. 2a.—Effect of KOH concentration on lactic acid formation at room temperature (24-30°C.)

1b). However, the increases thereafter were significant up to 1.5 N KOH. A significant decrease occurred at 2.0 N.

TABLE 1b.—*Effect of KOH concentration and length of time of reaction on the formation of lactic acid at room temperature (24-30° C.)*

TIME OF REACTION	TRIAL	KOH CONCENTRATION (N)					TOTAL
		1.0	.10	0.50	1.5	2.0	
hours		*milliequivalents per millimole of glucose*					
	1	0.0182	0.0923	0.4077	0.3017	0.5189	1.3388
	2	0.0113	0.0986	0.4163	0.4720	0.4855	1.4837
24	3	0.0085	0.0616	0.4264	0.5700	0.4892	1.5557
	4	0.0123	0.0752	0.4596	0.4533	0.4187	1.2191
	Ave.	0.0126	0.0819	0.4275	0.4492	0.4781	0.2899 [a]
	1	0.0128	0.0741	0.5863	0.9232	0.5126	2.1096
	2	0.0129	0.0576	0.4912	0.9293	0.5789	2.0699
48	3	0.0112	0.0912	0.5051	0.8809	0.5587	2.0471
	4	0.0147	0.1003	0.5539	0.9960	0.4975	2.1624
	Ave.	0.0129	0.0808	0.5341	0.9324	0.5369	0.4199 [a]
	1	0.0082	0.0763	0.5721	0.9843	0.7708	2.4117
	2	0.0108	0.1588	0.6364	0.9826	0.5085	2.2971
72	3	0.0093	0.0544	0.6799	1.0653	0.5463	2.3552
	4	0.0044	0.0636	0.5050	0.8519	0.6091	2.0340
	Ave.	0.0082	0.0883	0.5984	0.9710	0.6087	0.4549 [a]
Total		0.1346	1.0040	6.2399	9.4105	6.4947	23.2837
Mean		0.0112	0.0837	0.5200	0.7925	0.5412	

[a] Means for reaction times.

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE	SMD	
					0.05	0.01
Concentration	4	5.1896	1.2974	22.18 [b]	0.2151	0.3015
Time	2	0.3019	0.1510	2.58		
C × T	8	0.4682	0.0585	17.21 [b]	0.0850	0.1152
Sampling error	45	0.1509	0.0034			
Total	59	6.1106				

[b] Highly significant.

At boiling temperature (fig. 2b), the concentration means show that highly significant increases were obtained in succeeding alkali

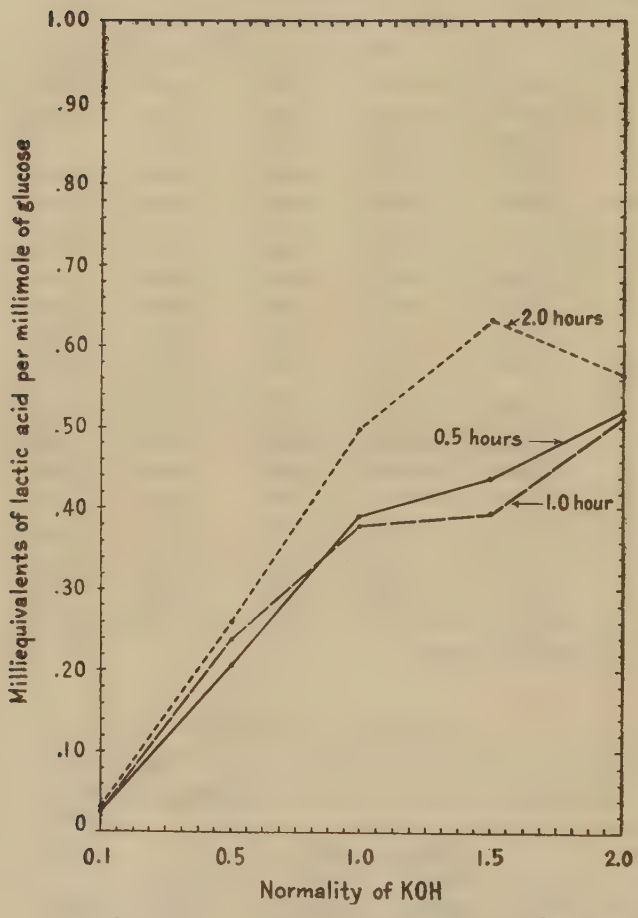

Fig. 2b.—Effect of KOH concentration on lactic acid formation at boiling temperature (100°C.)

concentrations up to 1.0 N (table 2b). Beyond this, further increases were not significant.

TABLE 2b.—*Effect of KOH concentration and length of time of reaction on the formation of lactic acid at boiling temperature (100° C.)*

TIME OF REACTION	TRIAL	KOH CONCENTRATION (N)					TOTAL
		.10	0.50	1.0	1.5	2.0	
hours		*milliequivalents per millimole of glucose*					
	1	0.0163	0.2385	0.3657	0.4182	0.4770	1.5157
	2	0.0156	0.1951	0.4041	0.4452	0.4684	1.5284
0.5	3	0.0297	0.1741	0.3563	0.4539	0.5638	1.5778
	4	0.0173	0.2031	0.4128	0.4294	0.5496	1.6122
	Ave.	0.0197	0.2027	0.3847	0.4367	0.5147	0.3117 [a]
	1	0.0211	0.2951	0.3369	0.3317	0.4819	1.4667
	2	0.0209	0.2306	0.4046	0.3941	0.5003	1.5505
1.0	3	0.0257	0.2065	0.3985	0.4354	0.5450	1.6111
	4	0.0226	0.2175	0.3734	0.4146	0.4955	1.5231
	Ave.	0.0228	0.2374	0.3784	0.3940	0.5056	0.3076 [a]
	1	0.0096	0.1996	0.5597	0.6692	0.5248	1.9629
	2	0.0361	0.2864	0.4609	0.5629	0.5550	1.9013
2.0	3	0.0331	0.2961	0.4706	0.6706	0.6453	2.1157
	4	0.0219	0.2304	0.4909	0.6082	0.5164	1.8678
	Ave.	0.0252	0.2531	0.4955	0.6277	0.5604	0.3924 [a]
Total		0.2699	2.7730	5.0344	5.8335	6.3225	20.2332
Mean		0.0225	0.2314	0.4195	0.4861	0.5269	

[a] Means for reaction times.

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE	SMD	
					0.05	0.01
Concentration	4	2.1028	0.5257	53.10 [b]	0.0885	0.1240
Time	2	0.0915	0.0458	4.63 [b]	0.0235	
C × T	8	0.0795	0.0099	7.62 [c]	0.0526	0.0713
Sampling error	45	0.0598	0.0013			
Total	59	2.3336				

[b] Significant.
[c] Highly significant.

Effect of length of time of reaction. Statistical treatment shows significant effect of the time of reaction at boiling temperature. The longer reaction times gave only slight increases at room temperature. However, reaction time and alkali concentration were found

to be interdependent as shown by the highly significant results of the interaction of the two variables. In both temperatures, reaction time produced no effect on lactic acid formation with the lower concentrations of KOH, 0.10 and 0.50 N, respectively (figs. 3a and 3b).

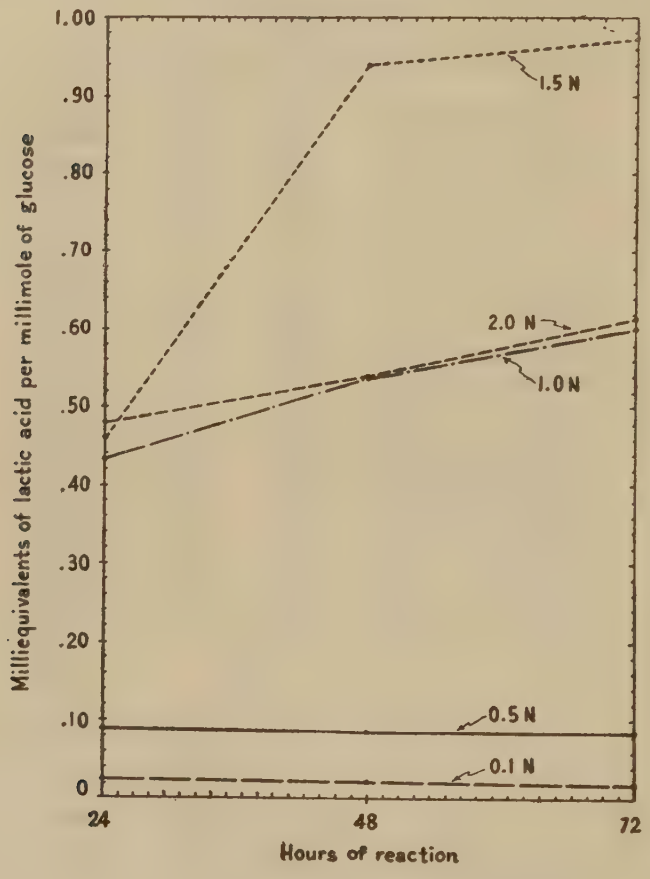

Fig. 3a.—Effect of length of time of reaction on the formation of lactic acid at room temperature (24-30°C.)

The fact that the increase in reaction time gave only slight increases in the amount of lactic acid formed at room temperature shows that reaction time is also dependent upon the temperature at which the reaction is carried.

At boiling temperature, a highly significant increase was observed at 2.0 hours reaction time. The differences between the amounts of acids formed at 0.5 and 1.0 hour reaction times were not significant.

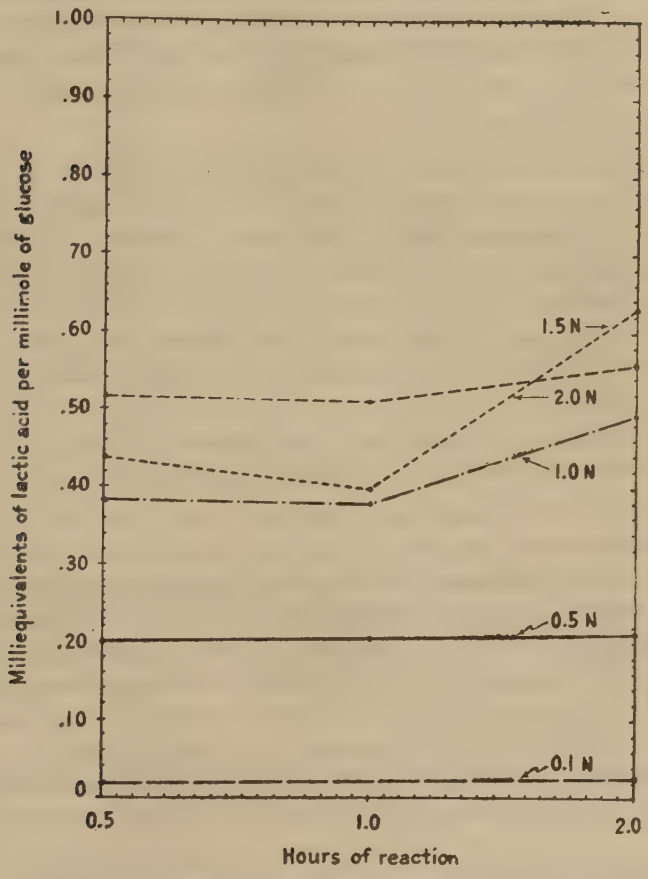

Fig. 3b.—Effect of length of time of reaction on the formation of lactic acid at boiling temperature (100°C.)

Effect of temperature. The effect of this variable cannot be explained well on the basis of results obtained from this experiment because the reaction times used for the two temperature conditions were not the same. Furthermore, reactions under room temperature had limited access to oxygen, unlike those at 100°C which were exposed to the atmosphere.

The data seem to indicate that lactic acid formation from hydrolyzed coconut milk by degradation may be accelerated by increasing the temperature of the reaction. Thus, an almost equal amount of lactic acid was formed after one-half hour at 100°C, and after 24 hours at room temperature when the alkali concentration (2.0 N) was the same. Maximum amounts of lactic acid were formed under the following conditions: (1) short time at high temperature, (2) longer time at lower temperature. A larger amount was formed under the second condition.

Formation of lactic acid. Theoretically, one mole of hexose can be converted to two equivalents of lactic acid. Montgomery, in citing the studies of Torstensen, Loch, Shaffer and Friedemann, Wiggins, Miyake, Hayashi, and Sano, mentioned yields of 60-67% of the theoretical from hexoses, 61.3-75% from sucrose as compared with 50% yield that he obtained. In this study, the highest yield obtained was 48.5% at room temperature and 31.4% at boiling temperature . These yields are perhaps due to the formation of other acids (tables 3a and 3b) which correspond under those temperature conditions to about 29% and 17% of the lactic acid formed, respectively.

Discussions above point out that lactic acid was the only acid formed in substantial amount. Experiments conducted with 1.5 N KOH at room temperature yielded as high as 12.39 milligrams per milliliter of hydrolyzed coconut milk after 72 hours of reaction. Such low amount indicates that coconut milk is not a promising source of lactic acid. The condition is due to the low concentration of the sugars in the coconut milk and the low conversion from sugars to lactic acid. Furthermore, the presence of proteins in the coconut milk may also reduce the yield of the acids by reacting with the reducing sugars in what is commonly known as the "Browning reaction."

Formation of other acids. The data presented in tables 3a and 3b are the total milliequivalents of the other acids formed. These acids were oxalic, glycolic and malic acids. They were not subjected to statistical treatment because the primary interest was centered on the predominant acid which was lactic acid. Comparing these values with those of lactic acid showed that at lower alkali concentrations (0.10 & 0.50 N) and at room temperature, the total amount formed of these acids exceeded that of lactic acid (tables 1a & 2a). However, at boiling temperature, similar results were obtained when the alkali concentration was 0.10 N.

TABLE 3a.—*Effect of KOH concentration and length of time of reaction on the formation of other acids at room temperature (24-30°C.)*

TIME OF REACTION	TRIAL	KOH CONCENTRATION (N)				
		0.10	0.50	1.0	1.5	2.0
hours		*milliequivalents* × 10^2				
24	1	20.31	22.02	26.06	20.26	15.88
	2	21.56	23.81	24.97	17.09	13.67
	3	21.30	26.87	—	21.66	18.16
	4	21.07	22.86	25.65	20.81	14.62
	Ave.	21.06	23.89	25.56	20.05	15.58
48	1	20.77	11.92	19.15	17.23	13.42
	2	29.22	18.49	18.30	16.90	19.41
	3	25.16	10.15	17.93	23.77	20.62
	4	22.51	16.00	19.43	16.44	15.62
	Ave.	24.41	16.64	18.70	18.58	17.20
72	1	26.35	26.63	25.98	20.29	18.05
	2	24.41	24.60	20.08	26.52	17.06
	3	21.76	20.97	23.00	27.24	18.54
	4	23.84	22.45	22.36	20.57	18.64
	Ave.	23.84	23.66	22.84	23.65	18.23

TABLE 3b.—*Effect of KOH concentration and length of time of reaction on the formation of other acids at boiling temperature (100°C.)*

TIME OF REACTION	TRIAL	KOH CONCENTRATION (N)				
		0.10	0.50	1.0	1.5	2.0
hours		*milliequivalents* × 10^2				
0.5	1	9.35	11.05	13.99	8.47	6.38
	2	5.43	4.47	4.49	3.75	4.16
	3	6.46	3.64	3.83	3.61	3.81
	4	7.28	5.96	4.83	4.65	5.26
	Ave.	7.13	6.28	6.79	5.04	4.90
1.0	1	8.17	11.51	9.04	3.45	2.93
	2	7.81	5.62	5.25	3.33	3.34
	3	3.77	8.19	7.29	6.55	4.34
	4	5.14	6.36	6.43	3.51	3.82
	Ave.	6.22	7.92	7.00	4.21	3.61
2.0	1	6.47	7.88	8.46	4.26	4.67
	2	3.14	8.73	5.22	6.37	6.42
	3	4.57	9.50	7.82	6.65	6.42
	4	5.15	8.41	6.84	7.21	5.39
	Ave.	4.83	8.63	7.08	6.12	5.51

It has been pointed out that lactic acid formation decreased when the alkali concentration was 2.0 N at certain reaction times (figs. 2a & 2b). This decrease in lactic acid cannot be explained in terms of the formation of the other acids. In both reaction temperatures, the results obtained showed a lower amont of the other acids at 2.0 N KOH than in any other concentration (tables 3a & 3b).

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A TECHNIQUE FOR SCREENING CROP PLANTS FOR RESISTANCE TO HERBICIDES

In a study designed to screen rice, corn and varieties of other crops for heritable resistance or tolerance to heavy dosages of herbicidal sprays, the following technique was found most suitable:

To protect the plants from fungus attack the rice seeds (Milfor 6 (2), Thailand, Raminand str. and Wagwag) were soaked in a solution of Orthocide 50 (2 lbs/100 gallons). The seeds were subsequently germinated in seedboxes and in glass plates covered with blotters. Samples were approximately 1000 seeds each. A four-gallon knapsack sprayer was attached to a one-meter boom with five nozzles. The boom was rigidly fastened to a box in order to give a uniform spray coverage. An aqueous solution of 2, 4-D amine was applied on week-old rice seedlings, at the rate of 10, 7, and 5 pounds per acre. The sprayed seedlings were watered one day after the application.

Among the important observations were: (1) the 10- and 7-pound-per-acre dosages were too concentrated and killed all the seedlings–the recommended dosage is only from ½ to 1 pound per acre; (2) at a solution temperature of 27°C, even the highest concentration of 2,4-D had no immediate effect on rice seedlings, but at 45°C, the effect of the spray was immediate; and (3) approximately 1 presumptive mutant was obtained from every 1207 seeds. These survivors formed new leaves one week after most of the seedlings were dead.

Seedlings surviving these drastic herbicide treatments will be transplanted in pots and allowed to head. The progeny will be increased and ultimately subjected to repeated drastic herbicide treatment. Simultaneously, unsprayed seedlings will be permitted to head and the "check" progeny will serve as basis for determining if a genetic gain in resistance would result from this screening-selection program. A similar technique was employed by Wheeler and Luke [1] in their mass screening for disease-resistant mutants in oats.

The results of this technique can be valuable in both basic and applied research. Herbicide resistant crops will permit farmers to

[1] Wheeler, H. E., and H. H. Luke. 1955. Mass screening for disease-resistant mutants in oats. Sci. *122* (3182): 1229.

eliminate weeds even in problem areas through the use of extremely concentrated herbicide application. Studies of the genetic and biochemical make-up of the resistant crop selections will aid plant scientists in understanding the reaction of living systems to environments of unusual stress.

O. Q. Ballesteros & H. L. Everett

——oOo——

Life would be intellectually simpler if we could abolish all science. We could suppress nuclear physics as we once outlawed the crossbow. But as long as man has his brains, we can't completely stifle his curiosity about himself and the world around him. It looks as if science is here to stay. We have passed the point of no return.

—*Sheldon C. Reed*

TRIAL CULTURE OF WHEAT

This study was an attempt to determine the adaptability of some wheat varieties to Los Baños conditions. Twenty varieties from Formosa and twenty from Santiago, Chile were planted in moist soil as in upland rice culture. At three weeks of age the cultures were fertilized with ammonium sulfate at 150 kilograms to a hectare. The two trials were made in January to March, 1954 and in October, 1954 to January, 1955.

In spite of good initial germination under laboratory conditions the South American varieties failed to germinate in the field. This was probably due to the deterioration of the grains while in storage. The Formosan varieties grew well and gave the following results:

VARIETY	AVERAGE YIELD TO A 2-SQ. M. PLOT	
	First trial	Second trial
	grams	*grams*
Eho Chuchon	25.8	107.9
Nanyu 26	16.8	14.2
Taichung 23	14.1	14.9
NARB 483	13.7	165.2
Ching Tao Shenli	13.4	97.6
Hsin-chen Tze	13.1	47.5
Hsin-chung-chang	10.4	26.6
Chungyu 125	10.0	27.7
Changchi 1	9.5	30.3
Taichung 32	9.2	—
Taichung 2	5.1	—
Montiga Wheat	5.0	—
Chungyu 200	4.8	—
Chungyu 120	4.1	—
Chungyu 180	2.0	—
Chungyu 105	0.0	—
Taichung 31	0.0	—
Chungyu 110	0.0	—
Chao Early	0.0	—
Chungyu 126	0.0	—

It was observed that varieties which matured late generally yielded more. Almost all varieties yielded more in the October-January trial than in the January-March trial because in the former water supply in the soil was most ideal for plant growth.

ARTURO F. ASPRER

——oOo——

IPIL-IPIL LEAF MEAL AS A SUPPLEMENT TO RATIONS FOR GROWING AND FATTENING PIGS

Although ipil-ipil (*Leucaena glauca* Linn.) has been recommended as feed supplement to poultry, its value as a supplement in swine rations has not been established. To explore this possibility 15 Berkjala weanling pigs were equally divided into three lots and fed the College standard rations which varied in their content of ipil-ipil leaf meal. Five per cent ipil-ipil leaf was added to the rations given to lot II and 10 per cent to lot III. The rations for lot I were unsupplemented. Management and care of the lots were made identical as much as possible.

Gain in weight and feed consumption of the lots after the 36-week feeding trial were:

	LOT I	LOT II	LOT III
Ave. gain in weight, kg.	54.04	67.94	75.30
Ave. feed consumed, kg.	291.68	354.65	376.15
Feed consumed per kg. gain	5.40	5.22	5.00

Differences among the lots were not significant. By converting the feed consumed into gain in weight, lot III was found to be most economical. At a computed cost of ₱0.18 per kilogram of feed mixture, it cost ₱0.90 to produce one kilogram of live weight in lot III; ₱0.94, in lot II; and ₱0.97, in lot I.

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